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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BIENNIAL REPORT

1911-1912

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NORTH CAROLINA GEOLOGICAL AND
ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

1911-1912

RALEIGH
Edwards & Broughton Printing Company, State Printers
1913

GEOLOGICAL BOARD

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LETTER OF TRANSMITTAL

Chapel Hill, N. C., January 10, 1913.

To his Excellency, Hon. W. W. Kitchin,
Governor of North Carolina.

Sir:—I herewith submit my Biennial Report on the operations of the North Carolina Geological and Economic Survey for the fiscal years 1911-12. I have included in this report several papers which, it has been thought, should be published for permanent record, but which it was not deemed advisable to publish as separate papers. I have also included recommendations regarding legislation that seems advisable from the various investigations carried on by the Survey. These recommendations are made in the form of bills, which, it is hoped, will be considered by the General Assembly of 1913. I wish to call your particular attention to the need for legislation relating to the prevention of forest fires; of engineering assistance to counties in public road work; to the need of increasing the appropriation to the Survey to enable it to employ a Drainage Engineer to have supervision of the organization of drainage districts; and to the protection of the commercial fisheries of the State and the establishment of a Fisheries Commission.

Throughout the past two years the State Survey has had the hearty coöperation of the various Federal Departments, and thus we have been able to accomplish a great deal more in the various lines of work taken up than it would have otherwise been possible.

Yours respectfully,

Joseph Hyde Pratt,
State Geologist.

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BIENNIAL REPORT

OF THE

STATE GEOLOGIST

On the Operations of the North Carolina Geological and Economic Survey for the Two Years Ending November 30, 1912

By JOSEPH HYDE PRATT, State Geologist

INTRODUCTION

In order to make a comprehensive report to the General Assembly of North Carolina of the operations of the North Carolina Geological and Economic Survey for the two preceding years, it is necessary to keep in mind the objects for which the Survey was created in 1905 and the additional work it has been authorized to do by succeeding Legislatures. There is, therefore, given below the objects of the Survey as enumerated in the act creating it and in subsequent acts.

As stated in the act, chapter 542 of the Public Laws of 1905, section 4, creating the Survey, the State Survey shall have for its objects:

1. An examination of the mineral, forest, fishery and other material resources of the State.

2. An examination of the geological formations of the State with reference to their economic products.

3. An examination of the road-building materials and the best methods of utilizing the same.

4. An examination and classification of the soils, the forests and other physical features of the State with special reference to their bearing upon the occupation of the people.

5. An examination of the streams and water-powers of the State with special reference to the development for manufacturing enterprises and the preservation of the sources of these streams through the protection of the forests.

6. The consideration of such other scientific and economic problems as in the judgment of the Geological Board shall be deemed of value to the people of the State.

7. The preparation of such reports, illustrations and maps as may be deemed necessary in placing the results of these investigations before the public.

8. And the State Geologist, with the approval of the Geological Board, is hereby authorized to arrange for and accept such aid and coöperation

from the several United States Government Bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this act.

9. An examination of the water supplies of the State with special reference to the sinking of deep or artesian wells.

In section 2 of chapter 915 of the Public Laws of 1909, it states: "The object and purpose of this appropriation shall be to enable the North Carolina Geological Board to advise with the township and county authorities in the building and improvement of the public roads, by sending to the township or county a competent road engineer, who will assist them in locating their improved roads, advise them as to the best road to build and how to build it, and also give advice relating to the best kind of bridge to be built in connection with the improvement of any road. The Geological Board, through the State Geologist, may make inquiries in regard to systems of road building and management throughout the United States, and make investigations and experiments in regard to the best kinds of road materials, and shall disseminate such knowledge by lectures to be given in the different counties and by preparing, publishing, and distributing bulletins and reports on the subject of road improvement, and shall also gather and tabulate information and statistics on road building in North Carolina and disseminate the same throughout the State."

As is seen from the above, the lines of work that are being undertaken by the Survey cover many fields, and their variation requires the employment of a number of men who are specialists in their particular line of work. For the past two years the personnel of the North Carolina Geological and Economic Survey has consisted of the following, who have been employed for either the whole or a part of the time:

Joseph Hyde Pratt, State Geologist.
F. B. Laney, Geologist.
J. E. Pogue, Geologist.
J. S. Holmes, Forester.
W. S. Fallis, Highway Engineer.
T. F. Hickerson, Highway Engineer.
W. L. Spoon, Highway Engineer.
J. M. Bell, Chemist.
Lawrence Brett, Drainage Engineer.
George M. Boyd, Drainage Engineer.
Miss H. M. Berry, Secretary.
R. P. Coble, E. L. Pickard, N. C. Hughes, Jr., R. T. Brown, Ira Mullis, C. R. Thomas, Jr., C. M. Miller, Assistant Road Engineers.
Della Richardson, Mrs. E. S. McGehee, Carrie Moses, Margaret Berry, May G. Hume, Stenographers.
Ernest Hutchins, W. A. Phillips, J. B. Lloyd, Ralph Andrews, B. D. Sykes, Ernest Kirkland, Office Assistants.

MINERALOGICAL AND GEOLOGICAL INVESTIGATIONS

Mineralogical Investigations

The collecting of statistics regarding the mineral production of the State and a review of the general conditions of the mining industry and the output of mineral production, represents the particular work that is done in mineralogy. The collecting of these statistics of the mineral production of the State has been done in coöperation with the United States Geological Survey. The same agreement that was in effect between the State and Federal Surveys for collecting mineral statistics for 1909-10 was in force for 1911-12.

It was deemed inadvisable to publish a detailed report of the mining industry of North Carolina each year, and therefore, every other year only a short statement is published in the form of a Press Bulletin, giving the actual statistics of the mineral production for the preceding year. The statistics for 1910 were publshed in Economic Paper No. 23, which also gave a very full discussion of the various phases of the mining industry in the State. The statistics for 1911 were published in Press Bulletin No. 86.

Mineral specimens are constantly being received at the Survey office for identification and analysis. While the majority of these do not represent anything of commercial value, yet occasionally one is found which does, and if there is any prospect of the mineral occurring in commercial quantity, the Survey assists in bringing the owner of the property in communication with those desiring such mineral. On the other hand, when the specimens prove to be of no commercial value, the Survey has, by notifying the sender of this, been able to save him the expense of chemical analyses and assays. The Survey makes no charge for the mineralogical determination of a mineral or rock, but if a chemical analysis is desired the work is turned over to one of the chemists of the State University, whose charges for this work are very reasonable.

During the past two years about three hundred samples of minerals have been examined and reported upon by the Survey.

Considerable information of interest and value to the work of the Survey relating to the occurrence of minerals in North Carolina is obtained through the collection of the mineral statistics and in connection with the identification of mineral specimens. This information will be used in the preparation of the general volume on the mineral resources of North Carolina, which is now in preparation.

Geological Investigations

The principal geological work for the past two years has been the completion of the report on the Virgilina Copper District. The manuscript and illustrations should be ready at a very early date for the public printer.

The report on the Coastal Plain Region of North Carolina has finally been completed and printed and is now ready for distribution. This report has been published in two parts, one relating to the geology of the Coastal Plain Region, and the other to the underground water resources of this same region.

The United States Geological Survey has carried on geologic work in North Carolina during 1911-12 in the following quadrangles:

Gaffney, North Carolina-South Carolina, quadrangle.—The final half of the work on the areal and economic geology of this quadrangle was completed in 1911 and 1912. This area takes in practically all of the quadrangle which is in North Carolina. Work was done by D. B. Sterrett with the supervision and coöperation of Arthur Keith.

Lincolnton, North Carolina, quadrangle.—Areal and economic geology of this quadrangle entirely completed during 1911-12. Work was done by D. B. Sterrett with the supervision of Arthur Keith.

Kings Mountain, North Carolina-South Carolina, quadrangle.—A small amount of review work was done by D. B. Sterrett, under the supervision of Arthur Keith.

Cowee quadrangle, North Carolina.—A review was made of the areal and economic geology on the new topographic base. About two months' total work in the two years by D. B. Sterrett and Arthur Keith.

Examinations have been made by Mr. Sterrett of the precious stone deposits in Burke, Cleveland, Macon and Mitchell counties, North Carolina. The results of these examinations are published in Economic Paper No. 23, on the Mining Industry in North Carolina.

MAPPING OF THE STATE

Topographic Maps

In the annual report of the State Geologist for 1909-10 there is given, on pages 20 and 22, a complete list of the topographic maps that have been published of portions of the State of North Carolina. During the past two years work has been done by the Topographic Division of the United States Geological Survey on the following maps:

The Lincolnton topographic map covering portions of Lincoln, Cleveland and Gaston counties, has been published.

The Abingdon topographic map covering about fifty square miles of Ashe County has also been published.

Copies of these maps can be obtained for ten cents each by writing to the Director of the United States Geological Survey, Washington, D. C., and enclosing money order for the amount due.

Primary traverse control and primary levels were completed on the Gastonia and Pleasant Ridge quadrangles.

The topographic maps are not for free distribution, but can be obtained from the Director of the United States Geological Survey for ten cents each, and in ordering them money order should be forwarded to the Director of the United States Geological Survey, and the maps should be ordered by name of the sheet. It should be noted that the price of these sheets has been increased to ten cents during the past year. Where one hundred sheets are ordered at one time, the price is six cents per sheet.

STATE MAP.

There has been completed during the past year a geographic map of the State of North Carolina on the scale of 1:500,000. It is printed in colors and is now ready for distribution. This map was prepared in coöperation with the United States Geological Survey.

COUNTY MAPS.

On account of a ruling of the United States Geological Survey, relating to the coöperation that has been in force for several years between the State and Federal Surveys in preparing the traverse maps of the various counties, which is to the effect that such coöperation shall not be operative unless the coöperation extends also to the preparation of a topographic map of the county as well as the traverse map, it is no longer possible for the State Survey to prepare county maps. As these topographic maps of a county would cost from $2,500 to $7,500 according to the size of the county, it has been impossible for the State Survey, with its limited appropriation, to take up any coöperative work along this line. The only work, therefore, that has been done during the past two years has been the preparation of the map of Pitt County, which is now in the hands of the printer. County maps that have been made by the Survey in coöperation with the Federal Survey and the counties, are Beaufort, Franklin, Granville, Cleveland and Pitt.

GOOD ROADS

The question of good roads throughout North Carolina continues to be one of the most important questions before the people of the State at the present time. The appropriation made by the General Assembly of 1909 of $5,000 annually to the North Carolina Geological and Economic Survey, with which to enable the Geological Board to advise with the township and county authorities in the building and improving of public roads, has been very largely supplemented during the past two years by the most hearty and cordial coöperation of the United States Office of Public Roads and the North Carolina Good Roads Association with the State Survey. The result has been not only the giving of actual assistance to counties in the location and method of construction of certain roads, but to arouse and stimulate a very general interest in good roads throughout the State.

County Good Roads Associations

This has led to the organization of a great many County Good Roads Associations, which have augmented the work of the State Association and of the Geological and Economic Survey. During the past two years Good Roads Associations have been organized partly through the efforts of the Survey in the following counties: Anson, Beaufort, Bladen, Burke, Camden, Carteret, Catawba, Chowan, Columbus, Craven, Cumberland, Currituck, Davie, Gates, Granville, Greene, Guilford, Harnett, Haywood, Hertford, Jackson, Johnston, Jones, Lee, Lenoir, Lincoln, Macon, Madison, Martin, Mecklenburg, Mitchell, Northampton, Orange, Pasquotank, Pender, Perquimans, Person, Pitt, Randolph, Richmond, Robeson, Rockingham, Rowan, Rutherford, Tyrrell, Union, Wake, Washington, Wayne, Wilkes, Yadkin.

Township Good Roads Associations have been organized as follows:

Burke County:
  Hildebrand Township Good Roads Association.
  Bridgewater Township Good Roads Association.
  Connelly Springs Township Good Roads Association.
  Glen Alpine Township Good Roads Association.

Caldwell County:
  Little River Township Good Roads Association.

Davidson County:
  Holly Grove Good Roads and Agricultural Association of Conrad Hill Township.
  Abbott's Creek Good Roads and Agricultural Association.
  Arcadia Good Roads and Agricultural Association.
  Alleghany Good Roads and Agricultural Association.
  Boone Good Roads and Agricultural Association.
  Cotton Grove Good Roads and Agricultural Association.
  Denton Good Roads and Agricultural Association.
  Cid Good Roads and Agricultural Association.
  Hampton Good Roads and Agricultural Association.
  Healing Springs Good Roads and Agricultural Association.
  Jackson Hill Good Roads and Agricultural Association.
  Liberty Good Roads and Agricultural Association.
  Midway Good Roads and Agricultural Association.
  Reedy Creek Good Roads and Agricultural Association.

Silver Hill Good Roads and Agricultural Association.
Thomasville Good Roads and Agricultural Association.
Tyro Good Roads and Agricultural Association.

Duplin County:
Island Creek Township Good Roads and Agricultural Association.

Davie County:
Jerusalem Township Good Roads Association.

Johnston County:
Benson Township Good Roads Association.

McDowell County:
Old Fort Township Good Roads Association.

Rowan County:
Gold Hill Township Good Roads Association.

It has not been possible to give all the assistance desired by counties in regard to the location, construction and maintenance of roads, but every possible consideration has been given all requests for such assistance, as they came into the office; and each request has been met to the fullest possible extent. Many times, however, the engineers have only been able to spend a day or two on the work; whereas if funds had been available, it would have been much better if they could have given weeks or even months to working out the road problems for that particular county.

The engineering assistance which has been carried on very largely in coöperation with the U. S. Office of Public Roads has consisted of:

1. Location of particular highways.
2. Advice regarding the best road to build and how to build it.
3. The construction of short sections of sample road.
4. The inspection of bridges.
5. The inspection of roads in regard to maintenance.

Educational Work

Another phase of the work has been along educational lines, and many addresses have been given throughout the different portions of the State concerning the value of good roads, how to obtain them, questions relating to bond issues, etc.

During the past two years, the State Geologist and his assistants have made good roads addresses at the following places:

State Geologist at:

Wadesboro, Anson County	Dec. 17, 1910
Raleigh, Wake County	Dec. 28, 1910
Nashville, Nash County	Dec. 29, 1910
Lillington, Harnett County	Dec. 30, 1910
Kenansville, Duplin County	Jan. 2, 1911
Whiteville, Columbus County	Jan. 3, 1911

Burgaw, Columbus County	Jan. 9, 1911
Fayetteville, Cumberland County	Jan. 10, 1911
Wentworth, Rockingham County	Jan. 14, 1911
Hertford, Perquimans County	Jan. 24, 1911
Smithfield, Johnston County	Feb. 10, 1911
Raleigh, Wake County	Feb. 14, 1911

Meetings in Connection with Central Highway—

Morehead City, Carteret County	May 8, 1911
New Bern, Craven County	May 9, 1911
Kinston, Lenoir County	May 10, 1911
Goldsboro, Wayne County	May 11, 1911
Smithfield, Johnston County	May 11, 1911
Raleigh, Wake County	May 12, 1911
Bakersville, Mitchell County	June .., 1911
Marshall, Madison County	June 5, 1911
Hot Springs, Madison County	June 5, 1911
Asheville, Buncombe County	June 6, 1911
Black Mountain, Buncombe County	June 6, 1911
Old Fort, McDowell County	June 6, 1911
Marion, McDowell County	June 7, 1911
Nebo, McDowell County	June 7, 1911
Morganton, Burke County	June 8, 1911
Hickory, Catawba County	June 8, 1911
Newton, Catawba County	June 9, 1911
Catawba Bridge, Iredell County	June 9, 1911
Mooresville, Iredell County	June 9, 1911
Statesville, Iredell County	June 10, 1911
Winston-Salem, Forsyth County	June 13-14, 1911

(Attending annual convention of the North Carolina Good Roads Association.)

Salisbury, Rowan County	June 15, 1911
Lexington, Davidson County	June 16, 1911
Thomasville, Davidson County	June 16, 1911
Burlington, Alamance County	June 17, 1911
Graham, Alamance County	June 17, 1911
Hillsboro, Orange County	June 17, 1911
Mebane, Orange County	June 17, 1911
Chapel Hill, Orange County	June 17, 1911
Raleigh, Wake County	June .., 1911

Halifax, Halifax County	July 25, 1911
North Wilkesboro, Wilkes County	July 21, 1911
Washington, Beaufort County	Aug. .., 1911
Winton, Hertford County	Aug. 5, 1911
Gatesville, Gates County	Aug. 6, 1911
Edenton, Chowan County	Aug. 7, 1911
Plymouth, Washington County	Aug. 8, 1911
Greenville, Pitt County	Aug. 10, 1911
Hendersonville, Henderson County	Aug. 15, 1911

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Ridgecrest, Buncombe County	Aug. 16, 1911
Greensboro, Guilford County	Aug. 17, 1911
(Before the trustees of Central Highway.)	
Concord, Cabarrus County	Nov. 3, 1911
Chapel Hill, Orange County	Feb. 29, 1912
Venable, Orange County	Mar. 9, 1912
Hillsboro, Orange County	Mar. 12, 1912
University, Orange County	Mar. 14, 1912
Spartanburg, South Carolina	Mar. 28-29, 1912
(Attending semi-annual Convention of the Southern Appalachian Good Roads Association.)	
Waynesville, Haywood County	Apr. 6, 1912
Fayetteville, Cumberland County	Apr. 6, 1912
Nashville, Tennessee (on Convict Labor)	Apr. 9, 1912
(Before Southern Commercial Congress.)	
Jacksonville, Florida (on Convict Labor)	Apr. 16, 1912
(Good roads address.)	
Fayetteville, Cumberland County	May 2, 1912
Anderson, South Carolina	July 5, 1912
Greensboro, Guilford County	July 8, 1912
Linville Falls, Burke County	July 17, 1912
Altamont, Avery County	July 18, 1912
Rutherfordton, Rutherford County	July 20, 1912
Mocksville, Davie County	July 25, 1912
Old Fort, McDowell County	July 26, 1912
Charlotte, Mecklenburg County	Aug. 1-2, 1912
(Attending Convention of the North Carolina Good Roads Association.)	
Altapass, Mitchell County	Aug. 20, 1912
Atlantic City, New Jersey (on Convict Labor)	Oct. 3, 1912
(Before the American Road Congress.)	
Smithfield, Johnston County	Nov. 15, 1912
Trinity, Randolph County	Nov. 23, 1912
Henderson, Vance County	Nov. 30, 1912

W. L. Spoon, Highway Engineer, at:

Roxboro, Person County	Jan. 2, 1911
Elkin, Surry County	Jan. 14, 1911
Winston-Salem, Forsyth County	Jan. 23, 1911
Boonville, Yadkin County	Jan. 27, 1911
Statesville, Iredell County	Feb. 4, 1911
Oxford, Granville County	Feb. 6, 1911
Hillsboro, Orange County	Mar. 14, 1911
Harrisburg, Cabarrus County	Aug. 23, 1911

H. B. Varner at:

Burgaw, Pender County	Feb. 7, 1911
Wallace, Duplin County	Aug. 10, 1911
Jerusalem Township, Davie County	Aug. 12, 1911
Hildebrand, Burke County	Sept. 8, 1911

Connelly Springs, Burke County	Sept. . ., 1911
Morganton, Burke County	Sept. . ., 1911
Drexel, Burke County	Sept. . ., 1911
Glen Alpine, Burke County	Sept. . ., 1911
Bridgewater, Burke County	Sept. . ., 1911
Troy, Montgomery County	Sept. . ., 1911
Snow Hill, Greene County	Sept. 2, 1912
Lincolnton, Lincoln County	Oct. 7, 1912
Conrad Hill Township, Davidson County	Nov. . ., 1912
Abbott's Creek Township, Davidson County	Nov. . ., 1912
Arcadia Township, Davidson County	Nov. . ., 1912
Alleghany Township, Davidson County	Nov. . ., 1912
Boone Township, Davidson County	Nov. . ., 1912
Cotton Grove Township, Davidson County	Nov. . ., 1912
Denton, Davidson County	Nov. . ., 1912
Cid, Davidson County	Nov. . ., 1912
Hampton Township, Davidson County	Nov. . ., 1912
Healing Springs Township, Davidson County	Nov. . ., 1912
Jackson Hill, Davidson County	Nov. . ., 1912
Liberty Township, Davidson County	Nov. . ., 1912
Midway Township, Davidson County	Nov. . ., 1912
Reedy Creek Township, Davidson County	Nov. . ., 1912
Silver Hill, Davidson County	Nov. . ., 1912
Thomasville, Davidson County	Nov. . ., 1912
Tyro Township, Davidson County	Nov. . ., 1912

Professor M. H. Stacy at:

Efland, Orange County	Mar. 16, 1912
Cedar Grove, Orange County	Mar. 17, 1912
Charlotte, Mecklenburg County	Aug. 2, 1912
(Attending North Carolina Good Roads Convention.)	
Winton, Hertford County	Aug. 5, 1912
Currituck, Currituck County	Aug. 6, 1912
Hertford, Perquimans County	Aug. 7, 1912
Edenton, Chowan County	Aug. 8, 1912
Gatesville, Gates County	Aug. 9, 1912
Swan Quarter, Hyde County	Aug. 12, 1912
Mackey's Ferry, Washington County	Aug. 13, 1912
Columbia, Tyrrell County	Aug. 14, 1912
Greenville, Pitt County	Aug. 15, 1912
Washington, Beaufort County	Aug. 16, 1912
Williamston, Martin County	Aug. 17, 1912
Yadkin Township, Stokes County	Nov. 26, 1912

W. S. Fallis, Highway Engineer, at:

Smithfield, Johnston County	Jan. 27, 1911
Elevation Township, Johnston County	Feb. 3, 1911
Siler City, Chatham County	Mar. 1, 1911

A. W. Graham at:

East Wallace, Duplin County	Aug. 22, 1911

H. P. Deaton at:
Harrisburg, Cabarrus County.................................Aug. 23, 1911
Chapel Hill, Orange County..................................Mar. 16, 1912

R. M. Phillips at:
Spring Hope, Nash County....................................July 5, 1911
Hillsboro, Orange County....................................Mar. 12, 1912

R. D. Douglas at:
Chapel Hill, Orange County..................................Mar. .., 1912
Charlotte, Mecklenburg County...............................Aug. 2, 1912
(Attending North Carolina Good Roads Association.)

Engineering Assistance to Counties

Engineering assistance was rendered counties and townships by the various road engineers connected with the Survey during the past two years as follows:

By W. L. Spoon:

January 4, 1911. Inspected and estimated cost of road near Wilmington for the Commissioners of New Hanover County.

January 11, 1911. Inspected certain roads in Cumberland County and advised with County Commissioners regarding their construction and maintenance.

January 13, 1911. Inspected roads in Forsyth County, and gave advice regarding their maintenance.

January 16, 1911. Gave assistance and advice as to the construction of sand-clay roads at Reidsville, Rockingham County.

February 18, 1911. Gave demonstration of the use of the split-log drag on one of the streets of Greensboro, Guilford County. Demonstration was held under the auspices of the Guilford County Good Roads Association.

February 11, 1911. Had supervision of the construction of a sand-clay road in Rockingham County.

February 14, 1911. Advised regarding the construction of sand-clay road at Greenville, Pitt County.

February 20-23, 1911. Gave assistance to Highway Commission of Cherokee County, regarding treatment of certain roads in the vicinity of Murphy.

February 27-28, 1911. Gave advice and assistance regarding sand-clay roads near Morganton, Burke County.

March 13, 1911. Located stretch of road at Kimball's Mill, near Oxford, Granville County.

March 16, 1911. Advised with the Commissioners of Graham, Alamance County, regarding general street improvement.

March 21-27. Located four miles of road leading from Green Park Hotel to John Ford's house, near Blowing Rock, Lenoir County. The location on the crest of the Blue Ridge had a maximum grade of 4½%.

March 29-30, 1911. Advice given as to the best way to build a road at Williamston, Martin County.

April 13-15, 1911. Inspection of proposed location of highway from Waynesville to the Tennessee line.

May, 1911. Surveyed and located road from the Seaboard Air Line Railway depot to Rutherfordton Hospital, in Rutherford County, a distance of one and a quarter miles. This road was constructed of sand-clay.

By T. F. Hickerson:

August, 1911. Survey for relocation of road from the town of Mount Airy towards the Blue Ridge Mountains, a distance of five miles, maximum grade 5 per cent. Location of a portion of the Central Highway between Old Fort and Marion. Inspection of the Central Highway through Wake County.

September and October, 1911. Location of the Central Highway in the counties of Orange and Alamance from White Cross to Saxapahaw, distance about twelve miles, maximum grade 4½ per cent.

March and April, 1912. Supervised the construction of a stretch of sand-clay road, nine feet wide, in the town of Chapel Hill.

April, 1912. Survey for the amount of grading necessary to reduce the grade to 4½ per cent, preliminary to macadamizing a section of road one mile long near Burlington.

June, 1912. Revision of portions of the Crest of the Blue Ridge Highway near Altapass.

August, 1912. Survey for the relocation of the road from Bakersville to Toecane, the most important road in the county; distance three miles, maximum grade 4 per cent. Five hundred feet of the proposed road encounters very expensive rock construction. The greater part of the location is along steep mountain slopes. Excellent sand is conveniently situated on the banks of Cane Creek for sand-clay construction. Slope stakes were set for a road width of twenty feet.

August, September, October, November, 1912. A few days during each month were spent on engineering work connected with the location and construction of the Crest-of-the-Blue-Ridge Highway.

October, 1912. Inspection of the Central Highway from Hillsboro to the Durham County line with R. T. Brown, Road Superintendent of Orange County.

November, 1912. Inspection of a gravel road from Asheboro towards the Montgomery County line, a distance of fifteen miles. Reconnaissance survey for a revision of the road from Graham to Snow Camp.

By R. T. Brown:

August, 1911. Surveyed and located road from Pittsboro to Bynum, Chatham County.

September, 1911. Spent several days in Lincolnton Township, Lincoln County, assisting in the location of a road, which was surfaced with sand-clay.

September, 1911. Assisted in locating Central Highway across Catawba County.

October, 1911. Located road in Henderson County to the Greenville County (S. C.) line along the route of the Asheville-Greenville Highway.

March, 1912. First week in March was spent in Mars Hill Township, Madison County, locating roads and giving advice as to the kinds of roads to build.

March 18-19, 1912. Gave assistance and advice regarding the maintenance of roads near Blowing Rock at Boone, Watauga County.

March, 1912. Located a highway running from Forsyth County line northwest via Walnut Cove, Danbury and Piedmont, Stokes County. This road is to be built by private parties and will probably be a toll road.

By E. L. Pickard:

June, 1912. Located route of Central Highway through Burke County.

July, 1912. Supervised construction of portion of Central Highway from Old Fort to Swannanoa Gap, McDowell County.

October, 1912. Located a road from Elk Park to Newlands, Avery County.

October, 1912. Surveyed and located a short stretch of road near Rutherfordton.

C. R. Thomas, Jr.:

Latter part of March, 1912. Spent several days at Norwood, Stanly County, locating a road for the township.

April, 1912. Located a road in Stantonsburg Township, Wilson County, and gave advice regarding surfacing it with sand-clay.

N. C. Hughes, Jr.:

1911. Supervised the construction of seven miles of sand-clay road in Moore County.

R. P. Coble:

April, 1912. Gave advice and assistance regarding location and construction of roads in Lee County.

W. S. Fallis:

February 13, 1911. Examined a macadam road at Tryon, Polk County, and gave advice as to the best way of repairing same.

Ira B. Mullis:

August, 1912. Located a short stretch of road between Weldon and Roanoke Rapids, Halifax County, which was surfaced with sand-clay.

C. M. Miller:

July, 1911. Located Central Highway across Davidson County.

Reports of Road Engineers

The following reports will illustrate the work that is being done by the road engineers in giving special engineering assistance to certain of of the counties and townships:

REPORT ON METHODS OF CONSTRUCTION AND ESTIMATE OF COST OF ROAD IMPROVEMENT IN STANTONSBURG TOWNSHIP, WILSON COUNTY, N. C.

General. Stantonsburg Township, of Wilson County, North Carolina, proposes to issue bonds to improve the roads and culverts within its limits.

Their reports cover the character of roads and culverts advisable, their construction and probable cost and the provisions to be made caring for the bonds.

The topography of the township is flat and intersected by many sluggish, winding streams. The soil is, for the most part, a sandy loam underlaid at a depth of 12 to 18 inches with clay.

Materials. Sand, clay and natural sand-clay mixture are the only materials available within the limits of the township for road construction.

Sand satisfactory for sand-clay road building must be coarse, and free from loam.

Clay should be tough and should not sun-crack or slake readily.

Sand and clay are found frequently mixed together and where there is one-third or more clay mixed with the sand it may be used for road surfacing.

South of Stantonsburg, to the township line, a very good quality of material is available on all the roads it is desired to improve.

North of Stantonsburg, the material is generally of an inferior quality, although at several points there are good indications of satisfactory material.

Location of Roads. Portions of several of the roads to be improved should be relocated as indicated on the accompanying sketch. The changes recommended will shorten the length and reduce the cost of construction wherever they are made. This is especially true on the Ruffin Bridge, Thompson Mill and Saratoga Roads.

Grading. There are no hills of importance that must be graded, but several fills from four to six feet high should be made at bridge and culvert approaches; and a long fill averaging five feet high on the Eureka road should be made.

The main part of the grading necessary will be for drainage purposes. Portions of all the roads to be improved will require deep drainage ditches and in many cases long outlet ditches to carry off the water. These must be carefully laid out by a surveyor to be satisfactory.

SAND-CLAY ROADS.

A sand-clay road has a surface of hardpan composed of sand and clay thoroughly mixed in such proportions that the sand grains are in contact, but firmly bound together by a clay filler. When sand-clay hardpan exists naturally it may be broken up and hauled to the road to be improved, where it will reconsolidate under travel. Where the clay and sand exist separately but reasonably close together, they may be combined to form this hardpan.

Ordinarily, the sand-clay surfacing rests upon a clay base or a sand base. Most of the roads in this township have a sand or sandy loam base upon which the surfacing is to be placed.

When a sand-clay surface is built upon a clay base, the method generally followed is to plow the clay road usually twelve to fifteen feet and spread a layer of sand about four inches deep over the plowed width. The road is then plowed, harrowed and dragged until the clay and sand are thoroughly mixed. This plowing, harrowing and dragging is done preferably after a rain when the clay is wet. In case the road still gets muddy after a rain a light coat of sand should be put on.

Another method is to spread sand upon the clay road when it is wet and allow the wheels of vehicles to mix it with the clay.

When a sand base is used, clay is spread about twelve inches thick (loose) at the center and eight inches at the sides (loose) for the width desired; and about two inches of sand pulled up from the sides on the clay with a road machine. This sand is plowed, harrowed and dragged until thoroughly mixed with the top portion of the clay and, if necessary, more sand added.

In case the clay is placed upon a sandy loam soil, it is advisable to haul sand to mix with the clay from a good sand bed and not to use the sandy loam soil on the clay.

This type of road is usually very bad in wet weather when new, but improves after it has been thoroughly wet.

Where a deep drainage ditch is necessary, place it on one side of the road only.

In sandy soil a twelve inch depth of ditch is sufficient.

The surfacing should be sixteen feet wide near towns.

CULVERTS AND BRIDGES.

The level character of the country necessitates many drainage ditches which must be provided for by a culvert when they cross a road, and many small streams which must be bridged.

It is recommended that a permanent type of culvert be used on all the roads to be improved, and that the abutments of all bridges be of concrete masonry.

A permanent culvert or bridge is the most economical improvement that can be made upon the road since it is the most lasting.

Culverts may be constructed of vitrified clay pipe, corrugated metal pipe or concrete. No pipe culvert should be used less than fifteen inches in diameter.

Vitrified clay pipe may be used where the earth cover is sufficient to protect it. This should not be less than eighteen inches. Where less earth cover is available, corrugated iron pipe should be used.

Concrete culverts are more expensive to construct, but are durable and should be used on the main roads to be improved near Stantonsburg.

Bridges consisting of steel I beams resting on brick or concrete abutments are recommended for two bridges to be put in.

ESTIMATE OF COST.

Eureka Road—1.75 miles.

3,000 lineal feet heavy fill	$1,700.00
1 mile grading at $300	300.00
1.75 miles sand-clay surface at $500	800.00
	$2,800.00

Crocker Farm—1.75 miles.

There are several sandy portions of this road which must be surfaced with sand-clay, averaging three-quarters of a mile altogether.

Three-quarters of a mile sand-clay, at $800	$600.00
Grading, 1¾ miles	300.00
	$900.00

Ruffin Bridge—1½ or 2 miles.

This road should be relocated throughout, as indicated on the accompanying sketch. If this can not be done, the portion from Mr. Stanton's house to the farm should be relocated. Two estimates are given; one, a total relocation, the other following the old road and relocating the portion beyond the Stanton place.

Total relocation—1½ miles.

Grading, 1½ miles	$600.00
Sand-clay surfacing, 1½ miles, at $600	900.00
	$1,500.00

Old road—2 miles.

Grading	$500.00
Sand-clay, at $500	1,000.00
	$1,500.00

Saratoga Road—1 mile.

This road should be relocated to the township line, as indicated on the sketch. This will necessitate a new bridge crossing Toisnot Swamp. The estimate is based upon relocation.

Grading	$400.00
Sand-clay surfacing	500.00
	$900.00

Thompson Mill Road—2 miles.

A new location is proposed, crossing Toisnot Swamp below the Norfolk Southern Railroad crossing. Some heavy grading will be necessary through the swamp.

Grading, at $300	$600.00
Heavy grading	400.00
Sand-clay surfacing, at $500	1,000.00
	$2,000.00

Wilson Road—6.25 miles.

Grading, at $150	$937.00
Sand-clay surfacing, at $500	3,125.00
	$4,062.00

Black Creek Road—2 miles.

The half mile of this road adjoining the creek should be relocated.

Grading, at $300	$600.00
1 mile sand-clay at $300	300.00
	$900.00

Moyton Road—6 miles.

Grading, at $200	$1,200.00
3 miles sand-clay surfacing, at $300	900.00
	$2,100.00

Edmonson Bridge Road—1 mile.

Grading, $500	$500.00
Sand-clay surfacing, one-half mile, at $500	250.00
	$750.00

Evansdale Cross Road—1½ miles.

Grading, at $300	$450.00

Culverts.	
12 18″ vitrified pipe, 28 feet long with headwater, at $40	$480.00
24 24″ vitrified pipe, 28 feet long with headwater, at $60	1,440.00
4 4x5 concrete culverts, 28 feet long, at $200	800.00
2 3x5 concrete culverts, 28 feet long, at $180	360.00
4 2x4 concrete culverts, 28 feet long, at $150	600.00
3 10-foot span concrete culverts 20 feet long, at $300	900.00
1 15-foot span concrete culvert 20 feet long	1,000.00
Bridges.	
1 20x12 I beam	500.00
1 30x10 I beam	600.00
1 80 ft. 15 ft. steel	1,200.00
	$7,880.00

Summary.

Eureka Road	$2,800.00
Crocker Farm Road	900.00
Ruffin Bridge Road	1,500.00
Saratoga Road	900.00
Thompson Mill Road	2,000.00
Wilson Road	4,100.00
Black Creek Road	900.00
Moyton Road	2,100.00
Edmonson Bridge Road	750.00
Evansdale Cross Road	450.00
Culverts and bridges	8,000.00
	$25,400.00
Contractor's profit, 15 per cent	3,400.00
Administration, engineering and inspection, 5 per cent	1,200.00
	$30,000.00

$30,000 is the amount recommended to complete the work outlined.

BOND ISSUE.

It is recommended that 40 year bonds bearing 5 per cent interest payable annually be issued to secure the funds necessary for this construction.

The tax necessary to care for the interest and provide a sinking fund for their retirement is shown in statement below.

Interest at 5 per cent on $30,000	$1,500.00
Amount which must be placed at 3½ per cent compound interest yearly to retire $30,000 at the end of forty years	355.00
	$1,855.00
Valuation in township	$500,000.00

Tax rate $= \frac{1855}{\$500,000}$ 37.1 cents on the $100.

Approved:
JOSEPH HYDE PRATT,
State Geologist.

C. R. THOMAS, JR.,
Engineer.

REPORT ON ROAD CONDITIONS IN LEE COUNTY.

Four days were spent in Lee County inspecting their material for road improvement, and looking into conditions as they exist there at the present time.

I met the chairman of the road commission (Mr. J. R. Jones), and with him and others went practically over all the principal roads of the county. I found the people in general to be very enthusiastic over the question of improvement, and I see no reason why the very best of results cannot be obtained there with the $100,000 they have to spend on their roads.

The location of some of the roads will necessarily have to be changed for the purpose of straightening, eliminating grade, and to obtain better drainage. Especially is this true of the northern half of the county where the country is more or less broken, and some of the roads at the present time very badly located. Here by relocation an easy grade with a maximum of four per cent can be reached with no great amount of difficulty and expense. The material for surfacing in this section must necessarily be gravel, and this is of excellent quality, and easily accessible from all points. The average cost of improving the roads in this part of the county I don't think need exceed $1,000 per mile, this to include everything complete.

In the southern half the conditions are somewhat different, the country is more level, with an abundance of sand. The location in this section need not be changed except in a few instances, for the purpose of straightening. The roads built here should be of sand-clay, and these need not exceed an average cost of $700 per mile, making the average cost of the roads in the county approximate $850 per mile.

The Geological Survey can render valuable service to the county in the way of advice and engineering assistance in the location and construction of their roads, and with this assistance and the natural advantages at hand, I see no reason why Lee County can not be one of the leading good roads counties in North Carolina.

Approved:
Joseph Hyde Pratt,
State Geologist.

R. P. Coble,
Road Engineer.

Report on Preliminary Location of Section of Spartanburg-Hendersonville Highway, Between Tryon and Tuxedo.

TRYON TO SALUDA LOCATION.

Two general routes from Tryon to Saluda were proposed by those interested; the one up the Pacolet River, the other over the Tryon mountain by way of Howard Gap. I ran a trial line at a five per cent grade from the Howard Gap to the foot of the mountain. This line was about three and one-half miles long and passed through much rock and across deep narrow ravines. It is not by any means a direct line from Tryon to Saluda. From Tryon to Lynn there is a good macadam road, and from Lynn to the foot of the mountain it would not be difficult to construct a road with a good grade. Between the Howard Gap and Saluda, a distance of about five miles, there would have to be a relocation of almost the entire road. Much of this, however, would be in good ground, though part of it would be on the north slope. The distance from Tryon to Saluda by this route would be at least twelve miles, one and one-half miles of which is now constructed and macadamized and possibly one mile more of the present road could be used if widened and drained.

The road by this route could probably be put in fairly good condition for travel at about the following cost:

Lynn to the foot of the mountain	$500	to	$750
Up Lynn Mountain 3½ miles, at $1,000 to $1,500	3,500	to	5,250
Howard Gap to Saluda, 5 miles, at $400 to $600	2,000	to	3,000
	$6,000	to	$9,000

If much rock were encountered other than what is indicated on the surface, the cost would probably exceed the above estimate.

The location made by way of the Pacolet Valley follows the street running by the girls' dormitory at Saluda, thence around the hill to Mr.

Bacot's, entering the present road again at the flat at the foot of the hill. From there it leads by an easy grade around the head of the hollow, crossing the ridge on the east side of the hollow and leading around the clearing at the head of Stony Creek. It follows the side of the hill on the west of the creek to the head of the gorge below the open fields, where it crosses to the hills on the east. It follows around to the southern slope to the mountain above the railroad, and thence more or less parallel to the railroad, down the side of the mountain to the burned house below Melrose. From there on the route runs with a survey made by Mr. Giles Pearson to the Mills plantation at the head of the valley.

The distance from Tryon by this route is about eight miles, and all the road with the exception of about 2,500 feet is on the sunny slope of the mountain.

The probable cost of putting this road in a fair condition for travel would be about as follows:

2.7	miles earth road on medium slope, at $400 to $600.......	$1,100	to	$1,650
⅛	mile earth, steep slope, at $600 to $700..................	75	to	90
⅜	mile rocky steep slope, at $1,000 to $1,200, about.........	400	to	500
¼	mile nearly all rock, steep slope, at $2,000 to $3,000......	500	to	750
1⅛	miles, averaging one-half rock, steep slope, $1,500 to $2,000	1,700	to	2,250
2	bridges, I beam or girder................................	600	to	800
		$4,375	to	$6,040

This estimate is based on a width of twenty feet or more except in the solid rock where a clear width or roadway of sixteen feet is assumed, this also covers the cost of culverts and sufficient tile for draining properly.

LOCATION SALUDA TO TUXEDO.

The route follows the upper street through Saluda and passes around the hill just west of the depot, crossing the hill at the little store on the bank of the railroad. It follows the side of the hill keeping near the railway right-of-way to the high railroad fill just outside the corporate limits. From there it leaves the railroad and follows the side of the hill on a four and one-half per cent grade to the mouth of the small hollow about three hundred yards from Pace's Mill. At this point it crosses the stream and runs in a westerly direction across the bottom, around the side of the hill on a four and three-fourth per cent grade and crosses the railroad at the top of the cut near the present road crossing. The cut is of sufficient depth to give a clearance of nearly thirty feet for trains. From there the line follows the northerly face of the mountain, to the mill bridge over Green River. It runs just back of Mr. Foister's house and enters the present road at the branch where the newly graded part begins. It follows the graded road, with a few changes where the grade is at present excessive, to the bridge. From the bridge the route leads upon a five per cent grade to the trestle where it passes under the railroad. From the trestle to Tuxedo the route follows the grade, crossing the first ridge near the house in the field, the second in the slight gap near the railroad cut. To cross the ridge running east from Tuxedo the line has to turn back along the side of the hill for several hundred feet, then cross to the north side and follow around that side to the station. The railroad crossing at Tuxedo is the only grade crossing between Tryon and Hendersonville, the other crossings being one by an overhead bridge and one underneath the trestle.

No special data was obtained for the cost of this section. There will be only about three and one-half miles of new road to construct, and some widening and smoothing up of the present road. With the present efficient convict force worked by Henderson County, the cost to the county would probably not exceed $1,000 or $1,200 to put the road in fair condition.

DRAINAGE.

With regard to drainage, I believe the whole route is the best that could be chosen consistent with allowable grades. Nearly all of the small stream hollows are crossed above the heads of the streams even at the time when the location was made, which was while the heavy snow was melting. Where the necessity for keeping the maximum grade did not prohibit the line was made to descend from both sides toward the hollows to avoid carrying the surface water too far in the side ditches. The location, with the exception of about 500 feet, is on the slope of the mountain, where the drainage is naturally good. At every stream crossing where culverts are needed, except two, suitable stone for culverts lies near at hand. In the three and one-half miles from Saluda to the gorge below Melrose only seven culverts, some of them very small,—only two large,— and eighteen or twenty tile drains are necessary for perfect cross-drainage.

MATERIAL FOR ROADBED.

Along almost the whole route the soil is a grit and clay mixture. There are only a few places where the clay predominates to such an extent as to get very muddy after a freeze. Between Melrose and Saluda much of the route is through a sandy soil that will make an excellent surface. From the crossing over Stony Creek to the middle of the Pacolet Valley below the gorge the road could be macadamized, if desired, at an unusually low cost as the rock is right at hand and much of it in a condition to be readily crushed.

RECOMMENDATIONS AND REMARKS.

I would recommend that work be begun on the parts not now open to traffic as soon as the weather permits, even though the money is not at hand to complete it. It is a road that must be opened eventually and the people should have the use of it now. At the point where my survey connects with Pearson's survey, near the old house site, the line should be carried around the hill on the side next the river instead of cutting through the saddle. By so doing part or all of the seven per cent grade required in his route can be eliminated. The survey as made by him crosses the river twice to avoid a solid vertical cliff. This will necessitate two bridges, one of which will probably be 80 foot span. These can be avoided by blasting a roadway along the side of the cliff. Though the latter plan would increase the first cost by several hundred dollars, it would be more satisfactory in the end, as it would avoid the repair and renewal of bridges and would keep the road on the sunny side of the hill. If four rows of loaded holes and one row of holes not loaded were put across the cliff, a space large enough for the road could be blown out at no very great cost. The row of unloaded holes should be put slightly below the grade of the roadway to cause the rock to break along a regular line. They should be spaced about four feet and drilled as deep as convenient. The loaded holes should be spaced five feet and should be staggered in the adjoining rows. The holes should all be fired at once. A good place for crossing the face of the cliff occurs higher up, but it is impossible to get down to the valley again without encountering several other cliffs and using an expensive grade as well.

If further information concerning the location is desired, I should be glad to be of service.

Approved: R. T. Brown,
Joseph Hyde Pratt, *Highway Engineer.*
State Geologist.

Report of the Work in Yadkin Township, Stokes County.

May 2d and 3d were spent in Yadkin Township endeavoring to interest the people of the township in a $25,000 bond issue for road improvement. I spoke to them at several points emphasizing the value of good roads and the bond issue as being the better method of financing them. The people as a rule did not seem very much interested, and appeared to have given the question little thought. They wanted roads but were undecided as to the better method of getting them.

The roads of the township at the present time are in very bad condition, with heavy grades and badly drained. The material is not the best, but with proper care in selection and attention in construction, a good road can be made with it. There is some creek sand that is accessible to part of the township, that can be used for sand-clay work.

If the people are allowed to vote on this bond issue the Geological Survey can render them valuable service by sending some one to speak to them on the value of good roads, and to explain the question of bonds more fully. If the bond issue should carry it will be very necessary that they have an engineer, for the problem of location will be a somewhat difficult one.

R. P. Coble,
May 29, 1912. *Engr. Geol. Sy.*

Co-operation of U. S. Office of Public Roads

The coöperation of the United States Office of Public Roads during the past two years has been very cordial and of very great value. Engineers of the Office gave lectures on Good Roads at the following places:

Place.	*Date.*	*Engineer.*
Scotland Neck	April 5, 1911.	J. E. Pennybacker.
Weldon	April 6, 1911.	J. E. Pennybacker.
Roanoke Rapids	April 7, 1911.	J. E. Pennybacker.
Pittsboro	May 9, 1911.	Chas. H. Hoyt.
Beaufort	June 5, 1911.	H. C. Wells.
Raleigh	June 12-13, 1911.	Chas. H. Hoyt.
Winston-Salem	June 14, 1911.	Chas. H. Moorefield
Williamston	June 14, 1911.	Chas. H. Hoyt.
Marshall	July 10, 1911.	Chas. H. Hoyt.
Asheville	July 10, 1911.	Chas. H. Hoyt.
Waynesville	July 11, 1911.	Chas. H. Hoyt.
Sylva	July 11, 1911.	Chas. H. Hoyt.
Bryson	July 12, 1911.	Chas. H. Hoyt.
Andrews	July 12, 1911.	Chas. H. Hoyt.
Murphy	July 13, 1911.	Chas. H. Hoyt.
Saluda	July 14, 1911.	Chas. H. Hoyt.
Hendersonville	July 14, 1911.	Chas. H. Hoyt.
Lake Toxaway	July 15, 1911.	Chas. H. Hoyt.
Brevard	July 15, 1911.	Chas. H. Hoyt.
Rutherfordton	July 17, 1911.	Chas. H. Hoyt.
Marion	July 17, 1911.	Chas. H. Hoyt.
Newton	July 18, 1911.	Chas. H. Hoyt.
Morganton	July 18, 1911.	Chas. H. Hoyt.
Statesville	July 19, 1911.	Chas. H. Hoyt.
Mooresville	July 19, 1911.	Chas. H. Hoyt.
Taylorsville	July 19, 1911.	Chas. H. Hoyt.

Place.	*Date.*	*Engineer.*
Mooresville	July 20, 1911.	Chas. H. Hoyt.
Mocksville	July 20, 1911.	Chas. H. Hoyt.
Winston-Salem	July 20, 1911.	Chas. H. Hoyt.
North Wilkesboro	July 21, 1911.	L. E. Boykin.
Mt. Airy	July 22, 1911.	L. E. Boykin.
Walnut Cove	July 22, 1911.	L. E. Boykin.
Reidsville	July 24, 1911.	L. E. Boykin.
Siler City	July 24, 1911.	L. E. Boykin.
Sanford	July 25, 1911.	L. E. Boykin.
Greensboro	July 25, 1911.	L. E. Boykin.
Asheboro	July 26, 1911.	L. E. Boykin.
Lexington	July 27, 1911.	L. E. Boykin.
Salisbury	July 27, 1911.	L. E. Boykin.
Concord	July 28, 1911.	L. E. Boykin.
Albemarle	July 29, 1911.	L. E. Boykin.
Graham	July 31, 1911.	L. E. Boykin.
Hillsboro	July 31, 1911.	L. E. Boykin.
Chapel Hill	Aug. 1, 1911.	L. E. Boykin.
Durham	Aug. 2, 1911.	L. E. Boykin.
Raleigh	Aug. 2, 1911.	L. E. Boykin.
Selma	Aug. 3, 1911.	L. E. Boykin.
Goldsboro	Aug. 3, 1911.	L. E. Boykin.
Henderson	Aug. 4, 1911.	L. E. Boykin.
Oxford	Aug. 4, 1911.	L. E. Boykin.
Asheboro	Nov. 2, 1911.	H. C. Wells.
Weldon	Nov. 25, 1911.	L. E. Boykin.
Halifax	Nov. 27, 1911.	L. E. Boykin.
Enfield	Nov. 27, 1911.	L. E. Boykin.
Whitaker	Nov. 27, 1911.	L. E. Boykin.
Rocky Mount	Nov. 28, 1911.	L. E. Boykin.
Nashville	Nov. 28, 1911.	L. E. Boykin.
Tarboro	Nov. 29, 1911.	L. E. Boykin.
Scotland Neck	Nov. 29, 1911.	L. E. Boykin.
Gates	Dec. 1, 1911.	L. E. Boykin.
Tunis	Dec. 1, 1911.	L. E. Boykin.
Ahoskie	Dec. 1, 1911.	L. E. Boykin.
Kelford	Dec. 2, 1911.	L. E. Boykin.
Williamston	Dec. 2, 1911.	L. E. Boykin.
Plymouth	Dec. 4, 1911.	L. E. Boykin.
Washington	Dec. 4, 1911.	L. E. Boykin.
Aurora	Dec. 5, 1911.	L. E. Boykin.
Vandemere	Dec. 5, 1911.	L. E. Boykin.
Greenville	Dec. 6, 1911.	L. E. Boykin.
Kinston	Dec. 6, 1911.	L. E. Boykin.
Wilson	Dec. 7, 1911.	L. E. Boykin.
Kenly	Dec. 7, 1911.	L. E. Boykin.
Smithfield	Dec. 8, 1911.	L. E. Boykin.
Dunn	Dec. 8, 1911.	L. E. Boykin.
Fayetteville	Dec. 9, 1911.	L. E. Boykin.

Place.	*Date.*	*Engineer.*
Fremont	Dec. 9, 1911.	L. E. Boykin.
Mt. Olive	Dec. 11, 1911.	L. E. Boykin.
Warsaw	Dec. 11, 1911.	L. E. Boykin.
Clinton	Dec. 12, 1911.	L. E. Boykin.
Rose Hill	Dec. 12, 1911.	L. E. Boykin.
Burgaw	Dec. 13, 1911.	L. E. Boykin.
Wilmington	Dec. 13, 1911.	L. E. Boykin.
Jacksonville	Dec. 14, 1911.	L. E. Boykin.
Polloksville	Dec. 14, 1911.	L. E. Boykin.
New Bern	Dec. 15, 1911.	L. E. Boykin.
Whiteville	Dec. 16, 1911.	L. E. Boykin.
Mt. Tabor	Dec. 16, 1911.	L. E. Boykin.
Rowland	Dec. 20, 1911.	L. E. Boykin.
Pembroke	Dec. 20, 1911.	L. E. Boykin.
Red Springs	Dec. 21, 1911.	L. E. Boykin.
Maxton	Dec. 21, 1911.	L. E. Boykin.
Wagram	Dec. 22, 1911.	L. E. Boykin.
Laurinburg	Dec. 22, 1911.	L. E. Boykin.
Marion	Dec. 27, 1911.	L. E. Boykin.
Stoneville	Dec. 8, 1911.	H. C. Wells.
Madison	Dec. 8, 1911.	H. C. Wells.
Madison	Dec. 8, 1911.	H. C. Wells.
Winston-Salem	Dec. 9, 1911.	H. C. Wells.
Walkertown	Dec. 9, 1911.	H. C. Wells.
Walnut Cove	Dec. 9, 1911.	H. C. Wells.
Welcome	Dec. 11, 1911.	H. C. Wells.
Lexington	Dec. 11, 1911.	H. C. Wells.
Lexington	Dec. 11, 1911.	H. C. Wells.
Ellers	Dec. 11, 1911.	H. C. Wells.
High Rock	Dec. 12, 1911.	H. C. Wells.
Southmore	Dec. 12, 1911.	H. C. Wells.
Newsome	Dec. 12, 1911.	H. C. Wells.
Norwood	Dec. 13, 1911.	H. C. Wells.
Cedar Hill	Dec. 13, 1911.	H. C. Wells.
Ansonville	Dec. 13, 1911.	H. C. Wells.
Albemarle	Dec. 13, 1911.	H. C. Wells.
Ansonville	Dec. 14, 1911.	H. C. Wells.
Wadesboro	Dec. 14, 1911.	H. C. Wells.
Oak City	Jan. 30, 1912.	H. C. Wells.
Grimesland	Jan. 31, 1912.	H. C. Wells.
Aurora	Feb. 1, 1912.	H. C. Wells.
Washington	Feb. 2, 1912.	H. C. Wells.
Bethel	Feb. 3, 1912.	H. C. Wells.
Williamston	Feb. 5, 1912.	H. C. Wells.
Plymouth	Feb. 6, 1912.	H. C. Wells.
Pantego	Feb. 7, 1912.	H. C. Wells.
Swan Quarter	Feb. 8, 1912.	H. C. Wells.
Middletown	Feb. 9, 1912.	H. C. Wells.

Fairfield	Feb. 10, 1912.	H. C. Wells.
Sladesville	Feb. 12, 1912.	H. C. Wells.
Mackey's Ferry	Feb. 13, 1912.	H. C. Wells.
Columbia	Feb. 14, 1912.	H. C. Wells.
Creswell	Feb. 15, 1912.	H. C. Wells.
Edenton	Feb. 16, 1912.	H. C. Wells.
Albemarle	Mar. 4, 1912.	H. C. Wells.
Greenville	Mar. 15, 1912.	D. H. Winslow.

ENGINEERING ASSISTANCE

Inspection and advice, including surveys, were given the following counties:

Carteret County.—During July, 1911, engineers H. C. Wells, J. T. Voshell and M. E. Worrell assisted the road commissioners in locating and constructing a sand-clay road from Morehead City toward Newport along the line of the Central Highway.

Craven County.—During July, 1911, H. C. Wells made an inspection of road conditions in this country with particular reference to the building of the Central Highway. Specific recommendations regarding the locations and changes in it were supplied. Special attention was given to the location of the road at Pine Grove in relation to the Norfolk Southern Railroad and to the bridge required near Havelock and the necessary grading of approaches. Work in this county was done in coöperation with the county engineer and no formal specifications or details were supplied. The importance of proper maintenance was pointed out and the improvement of the road machinery was recommended. Throughout nearly the entire length of the Central Highway in this county sand-clay construction is possible and economical.

Columbus County, N. C., January, 1911	C. C. Ahles.
Robeson County, N. C., January, 1911	C. C. Ahles.
Richmond County, N. C., January, 1911	C. C. Ahles.
Scotland County, N. C., January, 1911	C. C. Ahles.
Anson County, N. C., January, 1911	C. C. Ahles.
Cherokee County, N. C., August, 1911	R. E. Toms.
Orange County, N. C., July, 1911	M. E. Worrell.

MODEL COUNTY SYSTEMS

In several counties special road work was done not only in the supervision of the actual construction of several miles of road but in working out the location and method of construction for what could be a system of roads in the county. In several of these counties, the work done was in connection with the Central Highway.

Craven County.—During July, 1911, H. C. Wells, from this office made an inspection of road conditions in this county with particular reference to the building of the Central Highway. Specific recommendations regarding the location and changes in it were supplied. Special attention was given to the location of the road at Pine Grove in relation to the Norfolk Southern Railway and to the bridge required near Havelock and the necessary grading of approaches. Work in this county was done in coöperation with the county engineer and no formal specifications or details were supplied. The importance of proper maintenance was pointed out and the improvement of the road machinery was recommended. Throughout nearly the entire length of the Central Highway in this county sand-clay constuction is possible and economical.

Duplin County—Warsaw Township.—During September and October 1911, C. H. Moorefield, from this office, made a study of the road conditions in this township. A preliminary estimate was made for sand-clay and topsoil surfaced roads. A map was prepared showing the proposed location of fourteen roads, aggregating forty-six and one-half miles approximately. The estimate for improving these roads totaled $29,155.

Jones County.—Special attention was given to the Central Highway in this county during July, 1911, and a preliminary location for this road throughout the entire county was completed by H. C. Wells. Recommendations for surfacing materials and the construction of culverts and bridges were made. The improvement of the Central Highway will involve a number of relocations and considerable rectification of grade, all of which was covered in the report by the engineer from this office. In connection with this work recommendations were submitted to the county authorities for improving the road-building equipment with new machinery and tools, and for the employment of an engineer. Suggestions were made as to the future development of proper alignment with adequate width of right-of-way and of better drainage, and details for the construction of sand-clay roads were supplied. Special emphasis was placed upon the proper maintenance of the roads by the use of the split-log drag.

Lenoir County.—Work in this county involved a study of the location for two sections of the Central Highway. On both sections sand-clay construction for the surface is available and economical. Detailed information was developed showing all the necessary changes in the grade and alignment for the entire road. Recommendations for new culverts and bridges were made. In some portions of the road suitable gray topsoil is available and its location was indicated. General recommendations for the purchase of road-building equipment were submitted, together with suggestions for improved maintenance by the patrol system and the use of the road drag. It was recommended that an engineer be employed, and details were supplied for the information of the authorities concerning the width of the road and proper methods of shaping and constructing sand-clay surfaces. This work was done by H. C. Wells.

CONSTRUCTION OF OBJECT LESSON ROADS

Engineers of the Office of Public Roads also coöperated with the State Survey in the supervision of object lesson roads, as follows:

1. *Black Mountain, Buncombe County.*—On July 5, 1911, work was started on the road from Black Mountain toward the Sanatorium, and after July 8 the work was turned over to the local officials.

The maximum grade of 7 per cent was reduced to 6 per cent. The maximum cut was 2 feet and the maximum fill 1½ feet. The natural soil was clay and the excavation was handled with a road grader and slat-bottom wagons. The average haul was 530 feet and the maximum 1,000 feet. The distance from the sand pit to the road was about two miles. Both sand and clay contained too much mica to make a good road. The total length graded 22 feet wide was 1,750 feet. A total of 525 feet was surfaced 12 feet wide. The total amount of earth excavation was 265 cubic yards and the amount of surfacing material 65 cubic yards. This work was done under the supervision of C. H. Moorefield.

The total cost of work, including labor on the drag, was $116.63. The cost per square yard was $0.166, and the rate per mile $1,172.16.

2. *Calypso, Duplin County.*—Between August 28 and September 20, 1912, two sections of sand-clay and topsoil road were constructed under the supervision of W. J. R. Weir, road engineer.

3. *Goldsboro, Wayne County.*—The La Grange road was built from Goldsboro eastward toward Kinston between August 2, 1911, and September 18, 1911. The material from station O to station 15 was a hard gray topsoil with a black loam subsoil; from station 15 to station 23, sandy topsoil and clay subsoil; from station 23 to station 46, a natural sand-clay mixture; from station 46 to station 57, clay; from station 57 to station 59, sand; and from station 59 to station 73, sand with clay subsoil. At station 52 1,000 feet of road was relocated to improve the alignment. The maximum cut was 18 feet, the maximum fill 6.5 feet, the average cut 0.5 foot, and the average fill 0.6 foot. The grade was reduced from 7.5 per cent to 4.95 per cent. The total length graded was 7,300 feet, the width 30 feet, and the area 24,333 square yards. The surfacing material consisted of natural sand or gravel clay. The length surfaced was 5,800 feet, the width 24 feet, and the area 15,466 square yards, of which 2,133 square yards was surfaced with clay from a pit, and 13,333

square yards with clay taken from the side ditches. The crown was made 0.75 inch to the foot. The excavated material amounted to 5,426 cubic yards, and the following equipment was used: 1 road machine, 4 wheel scrapers, 11 single-horse dump carts, 4 slip scrapers, 1 rooter plow, 1 turning plow, and hand tools. A 30-foot span wooden bridge 20 feet wide was built.

The total cost of the work was $1,199.50; the cost per square yard, $0.049; and the rate per mile, $867.50. Labor was performed by convicts estimated at $0.50 per day, county mules at $0.50 each, and hired mules at $1.00 each. The principal items of cost were as follows: Excavation, $813.95; shaping and subgrade, $72.50; clearing and grubbing, $40.35; moving fences and poles, $9.20; dragging, $0.95; loading clay, $30; hauling clay, $81; spreading clay, $6, and maintenance of the camp, $82.05. The bridge was built by contract at an estimated cost of $63.00. H. C. Wells was road engineer in charge of the work.

4. *Hickory, Catawba County.*—A sand-clay road running southward from Hickory toward Brookford was started on November 14, 1911, and completed on December 2, 1911. The country is hilly and the soil clay. Excavation was made by plowing, and the material was moved with single-mule slip scrapers and spread with shovels. The grading required no appreciable cuts or fills, and the maximum grade was 5.6 per cent. One 18-inch vitrified pipe culvert, 40 feet long, was laid without end walls. A plank drag was built for the work. The sand used for surfacing was hauled ⅝ mile. The total length regraded was 1,050 feet, with a width of 24 feet. The same length was surfaced 16 feet wide, making the area surfaced 1,867 square yards. The surfacing was 6 inches thick when compacted, and the crown 1¼ inches to the foot. The earth excavation amounted to 135 cubic yards, and the sand for surfacing, 395 cubic yards.

The cost of the work was $198; the cost per square yard, $0.106; and the rate per mile, $995. Labor cost $1.00 per day, and teams $2.50 per day. The principal items of cost were: Excavation, $25.75; shaping the subgrade, $12.50; labor on the culvert, $4.75; hauling the sand, $105.25; spreading the sand $17.75; mixing, $5.50; cement, $0.50, and vitrified pipe, $26.00.

5. *Jerusalem (Mocksville), Davie County.*—A sand-clay road was constructed under the supervision of C. R. Thomas, J. W. Jansen, and W. E. Rosengarten. The work was started August 20 and finished November 1, 1912.

6. *Kinston, Lenoir County.*—A sand-clay road leading westward from Kinston toward La Grange, called the La Grange road, was graded for a distance of 4,100 feet and surfaced 3,000 feet with a natural sand-clay mixture. The work, performed by convict labor, was

started on August 24, 1912, and completed on September 28, 1912. The road was first plowed and the material was transported in wheel scrapers and wagons, and spread with shovels. The average cut was 0.6 foot, and the maximum grade 1 per cent. The natural soil was black sandy loam, unsuitable for mixing with clay. One 24-inch vitrified pipe culvert 30 feet long, a wooden bridge having a span of 8 feet, and a 20-foot roadway were built. The equipment consisted of a road machine, 2 wheel scrapers, 3 slat-bottom wagons, and 1 plow. The average haul was 200 feet for excavation and 0.66 mile for surfacing material from the pit. The road was graded 30 feet wide, and the area was 13,666 square yards. The width surfaced was 16 feet, and the area 5,333 square yards. The surfacing material was compacted to a depth of 6 inches, and the crown of the roadway made 0.75 inch to the foot. The earth excavation amounted to 699 cubic yards, and the surfacing material 1,185 cubic yards. Labor and material for the bridge cost $15.75.

The total cost of the road to the community was $573.35; the cost per square yard, $0.05; and the rate per mile, $865.92. The superintendent was paid $2 per day; hired teams, $3, and guards $1. Convicts were figured at $0.40, and the county teams at $1 per day.

7. *Lexington, Davidson County.*—Between July 7 and August 20, 1912, a sand-clay road was constructed under the supervision of C. R. Thomas and W. E. Rosengarten.

8. *Monroe, Union County.*—From October 10 to December 2, 1912, W. J. R. Weir superintended the construction of a macadam road.

9. *Moyock, Currituck County.*—The work of building a sand-clay road northwest from Moyock was started on October 19, 1911, and continued until November 17, 1911. The soil from station 0 to station 1 is sand-clay with an excess of sand; from station 1 to station 2, clay; from station 2 to station 10, sand-clay containing an excess of sand; from station 10 to station 15 the mixture of sand and clay is well proportioned; and from station 15 to station 18 there is a slight excess of sand.

The equipment consisted of one 4-horse road plow, 1 disk cutter, 1 disk riding plow, 1 harrow, and a road grader. Some of the material was handled in carts, then dumped and spread by hand, although most of the grading was done with slip scrapers.

The average haul was 50 feet and the maximum haul 1,700 feet. The subsoil was used for a foundation and a sand-clay mixture for the surfacing. The total length built was 1,800 feet with a width of 20 feet, and the crown was made 1.8 inches to the foot. The earth excavation amounted to 352 cubic yards.

The cost of the road was $113.48; the cost per square yard, $0.2837; and the rate per mile $332.87. Labor cost $1.25 per day, and team with driver $3.25 per day. It was very difficult to obtain men and teams.

This work was done under the supervision of H. J. Langlois, J. R. Shidler, and M. E. Worrell.

10. *North Wilkesboro, Wilkes County.*—Between September 17 and December 23, 1912, a macadam road was built from North Wilkesboro to Wilkesboro, under the supervision of H. C. Wells and Herbert Creighton.

11. *Warsaw, Duplin County.*—The work of building a sand-clay road from Warsaw southward toward Kenansville was begun November 4, 1911, but discontinued December 22, 1911, after one mile of road had been built. The work was done under the supervision of E. W. James and J. R. Shidler.

The soil is sandy, with a light red subsoil of clay and white sand. The proportion of sand in the subsoil is from ⅔ to ¾, making a good mixture. The surface was first plowed, thereby turning the sand under and bringing the subsoil to the surface. It was then mixed with a disk harrow, shaped with grader and drag, and leveled with slip scrapers where necessary, and material was added from the ditches or nearest clay pits. The maximum cut was 1 foot, the maximum fill 3.1 feet, and the maximum grade of 3 per cent was reduced to 2½ per cent.

One 18-inch corrugated metal culvert, 23 feet long, two 18-inch metal culverts each 21 feet long, and two 10-inch vitrified pipe culverts, each 21 feet long, were laid without end walls, and a 15 foot span skew bridge was built with brick wing walls 22 feet long and 4.6 feet high above the footings with plank floor and guard rails. The footings were 2 feet deep and 2.9 feet wide. The abutment walls were made 22 feet long, 2 feet thick at the bottom and 1 foot 8 inches thick at the top. The wing walls were built for a 1 to 1 slope.

The maximum haul was 1,000 feet, the average haul 200 feet, and the average haul from the pit 500 feet. The total length of road built was 5,280 feet, the width of grading 20 feet, and the area graded 11,703 square yards. The surfacing material was spread 14 feet wide, making the area surfaced 8,213 square yards. The surfacing was 8 inches in depth, and the crown 1½ inches to the foot. The estimated amount of earth excavation was 1,914 cubic yards, and of surfacing material 1,200 cubic yards.

Twenty barrels of cement, 5 barrels of lime, 10 cubic yards of sand, 15,500 bricks, 2,074 feet b.m. of pine lumber, and 78 pounds of nails were used in building the bridge.

The total cost of the work was $1,070.25; the cost per square yard surfaced, $0.13; and the rate per mile, $1,070.25. Labor per ten hour day cost $1.25; foremen per day, $2.50, and mules per day $1.50.

The principal items of expense were grading $247.12; shaping the subgrade, $56.25; culverts, including labor, $88.12; abutment walls, including excavation for them, $322.32; loosening and loading clay, $42.49; hauling from pit, $138.19; spreading surfacing material, $24; clearing and grubbing, $53.54; dragging $10.50; and trimming the shoulders and ditching, $87.72.

12. *Williamston, N. C.*—April 17 to May 24, 1911. E. W. James.
13. *Wilson, N. C.*—May 7 to June 23, 1911. C. H. Moorefield.

INSPECTION OF OBJECT LESSON ROADS

As far as possible object lesson roads that have been built are inspected from time to time for the purpose of determining their present condition, the amount of maintenance received or required, condition of culverts, present traffic conditions, increase of traffic, if any, the adaptability of a road to traffic conditions, and the effect upon future road work. The following examination was made in North Carolina:

Greenville, N. C.—A sand-clay road was built at Greenville in November, 1909, and inspected in March, 1912. It was found to be very muddy and deeply rutted. The crown of the road is well preserved and the alignment and grade are satisfactory. The road has received no maintenance whatever and at the present time needs a treatment of sand. There is evidence that too much clay was used in the construction, and this is generally true of other sand-clay roads in Pitt County. The pipe culverts are in poor condition—head walls were not built, and the ends of the pipe are broken. Nearly all the culverts are blocked with brush and other debris. They were not built under the direction of this office. The traffic, however, has materially increased. The office supervised the first improved road in the county, and a few miles, modeled after this first section, have since been built. Generally speaking, the sand-clay construction has not been satisfactory. This examination was made by D. H. Winslow.

BRIDGE WORK

The United States Office of Public Roads has also assisted the State in regard to the designing and construction of highway bridges and culverts. An object lesson bridge was worked out at Goldsboro, Wayne County, by W. H. Rhodes and H. C. Wells.

Two abutments of Portland cement concrete for an eighty-foot span steel bridge over Little River were constructed on the Central Highway in Wayne County at the State hospital. Work began on March 5, 1912, but was discontinued on March 15 on account of continued high water. On April 23 the work was resumed, and the project was completed on June 10, 1912. The foundations are gravel on the east side of the river and sand on the west side. The excavation was made by hand, and the material was removed with wheelbarrows and carts. Water was kept out of the cofferdams by means of a one and one-fourth inch diaphragm pump. The aggregate for concrete consisted of gravel from one-half inch to one and one-fourth inches in diameter and fairly good sand. The materials were mixed in the proportion of one part Portland cement, two parts sand, and three and one-half parts gravel. Gravel was obtained from a pit and hauled one and one-half miles.

The haul for sand was one-half mile. The following quantities were handled: Two hundred and fifty cubic yards of earth excavation, 168.5 cubic yards of concrete, 147 cubic yards of gravel, 73 cubic yards of sand, and 261¾ barrels of cement.

The total cost of the abutments was $964.53. The principal items of cost were excavation, 250 cubic yards, at $0.208 a yard, $51.96; hauling gravel, 147 cubic yards, at $0.39 a yard, $57.50; hauling sand, 73 cubic yards, at $0.14 a yard, $10.20; cofferdam piling, $22.84; pumping, $53.76; screening gravel, 147 cubic yards, at $0.49 a yard, $73.00; forms, $47.54; mixing and placing concrete, $149.58; cement, 261¾ barrels at $1.44 a barrel, $376.92; lumber, $113.68, nails, $4.55; and wire, $3.00. The laborers employed were patients from the hospital, and the cost per patient was figured at $0.40 per 10-hour day. The cost of foremen was $1.00 per day and of carpenters $1.50 per day.

SPECIAL INSPECTION AND ADVICE

1. *Calypso.* September 20 to 22, 1912; by W. J. R. Weir.
2. *Hobbsville.* September 15 to October 3, 1912; by W. J. R. Weir.
3. *Gatesville, Gates County.* October 7, 1912; by E. W. James.
4. *Monroe, Union County.* October 3 to December 2, 1912; by W. J. R. Weir.
5. *Raleigh, Wake County.* August 30, 1912; by E. W. James. Special conference with Senator Simmons regarding road work in the State.

Road Materials Tested

Twenty-eight samples of rock from North Carolina were tested at the Office of Public Roads as to their suitability for road surfacing.

No.	*Rock.*	*County.*
5498.	Sandstone	Alamance.
5499.	Sandstone	Alamance.
5500.	Sandstone	Alamance.
5501.	Sandstone	Alamance.
5570.	Decomposed stone	Alamance.
4991.	Sil.-Shell Lime	Beaufort.
5047.		Harnett.
5373.	Gneiss	McDowell.

5430.	Granite Gneiss	Polk.
5463.	Gravel	Richmond.
5464.	Gravel	Richmond.
5449.	Micro-Granite	Rockingham.
5450.	Micro-Granite	Rockingham.
5451.	Micro-Granite	Rockingham.
5496.	Granite	Rowan.
5668.	Alt. Granite Porp	Rowan.
5629.	Alt. Syenite Porp	Rowan.
5497.	Granite	Surry.
5374.	Quartzite	Yancey.
6196.	Mica schist	Cherokee.
6197.	Sericite schist	Cherokee.
6198.	Sandstone	Cherokee.
6199.	Marble	Cherokee.
5873.	Granite	Mecklenburg.
5956.	Granite Gneiss	Rockingham.
5719.	Granite	Rowan.
5866.	Epidosite	Stanly.
5867.	Steatite	Stanly.
5868.	Steatite	Stanly.
6071.	Biotite Gneiss	Rutherford.
6301.	Sandstone	Union.
6284.	Mica Gneiss	Wilkes.

Experiments With Glutrin on a Sand-Clay Road

In 1911 the Robeson Process Company furnished the North Carolina Geological and Economic Survey a sufficient amount of glutrin, a product manufactured by them for applying to roads as a binding material, to use on three hundred (300) feet of sand-clay road. The road tested was a sand-clay road that had been constructed in the eastern part of the town of Chapel Hill, on the Durham road, and which had been in use for about two years. The road bed was a heavy red clay to which a rather coarse sand was added and well mixed with the clay, making a sand-clay mixture of about six inches.

Before applying the glutrin the surface of the road was saturated with water by means of a sprinkling wagon. In this way the road was softened and in a condition to permit the glutrin to penetrate through and into the sand-clay mixture. Before adding the glutrin it was diluted with water in the ratio of one to one. Glutrin is soluble in water, and the method of diluting was pouring into the sprinkling cart an equal amount of water and glutrin, which readily mixed with each other. This was then applied to the surface of the road by means of the sprinkling cart, and the proportion of glutrin used on the road was approximately one gallon to each square yard of road. The solution penetrates slowly into the sand-clay mixture, and when it dries out the surface of the road is discolored but very little from the natural color of the sand-clay and a surface has been formed that readily sheds water, and also keeps down the dust. There is evidently some chemical reaction that takes place between the glutrin and the particles of clay, as it hardens the road and prevents washing by rain.

A short section of gravel road was also tested with glutrin using the same proportions as for the sand-clay road, and very similar results were obtained, the principal difference noted being that a harder metallic surface was obtained with the gravel road than with the sand-clay road.

Both the sand-clay and gravel roads remained hard and firm during the very severe winter of 1911 and 1912, and dried out very much more quickly than the sand-clay or gravel roads that had not been treated with glutrin. Another noticeable difference was that the sand-clay and gravel roads treated with glutrin did not wash in even the severest rains.

In 1912 another application of glutrin was made to both the sand-clay and gravel roads of approximately one-half gallon of glutrin to each square yard surface of the road. This did not seem to change the general condition of the road or give any added benefit beyond the laying of the dust.

Another experiment that the Survey wishes to try in connection with glutrin is the application of glutrin to the sand-clay road, and then follow this in about two weeks with an application of some light road oil; this in turn to be covered with a thin layer of sand, just sufficient to absorb the excess oil. It is believed that the glutrin will bind the sand-clay road into a perfectly hard road, and the application of the oil will make it waterproof; and thus, at comparatively small expense, a perfectly hard, smooth, waterproof road surface can be obtained.

Co-operation With Good Roads Associations

The Survey has been very closely identified with the work of the North Carolina Good Roads Association, and has assisted in planning for and carrying through two Good Roads Conventions, one held at Winston-Salem, June 13-14, 1911; and the other at Charlotte, August 1-2, 1912. The State Geologists have been secretary of this Association ever since it was organized.

Another Association with which the Survey has been closely identified is the Southern Appalachian Good Roads Association. This Association was organized at Asheville, N. C., in 1909, and its object is to encourage the construction of good roads in the Southern Appalachian Mountains. The principal part of the work was in North Carolina, and for this reason the State Survey has assisted the Association in every way possible to get good roads for this Southern Appalachian region. It is believed that the coöperative work between the State Survey and this Association has been mutually beneficial.

As authorized by the Geological Board the State Geologist has assisted in every way possible to encourage the construction of the Crest of the Blue Ridge Highway, and has devoted considerable time to the engineering work on this Highway.

Road Exhibits

Another way in which to call attention to the road work that is being carried on in the State and to show the effect of good roads on the communities in which they have been constructed, which the Survey has undertaken during the past two years, has been in the making of three exhibits which, it is believed, have done considerable to arouse interest not only in the road work of the State but in the State generally as a place for investment. The principal one of these exhibits was made at Atlantic City, N. J., in connection with the American Road Congress. The Congress was in session for one week and was visited by thousands of people not only interested in good roads but in obtaining information regarding the States themselves. The State exhibit consisted of photographs illustrating the roads built throughout the various counties, and also views of the surrounding country. Maps and charts had also been prepared and were exhibited showing the location of the various highways. Road materials were exhibited to some extent. The counties aiding the Survey in preparing photographs for this exhibit were: Carteret, Craven, Wayne, Wake, Durham, Orange, Guilford, Rowan, Iredell, Catawba, Burke, Buncombe, Haywood, Henderson, Mecklenburg, Forsyth, New Hanover, Nash, Edgecombe, Anson, Moore, and Franklin.

Similar exhibits, but on a smaller scale, were made at the State Fair at Raleigh during 1911.

The Central Highway

The General Assembly of 1911 authorized the construction of the Central Highway and the North Carolina Geological and Economic Survey was instructed to locate this highway acoss the State, from Beaufort Harbor to the Tennessee line. The act referred to is as follows:

AN ACT TO PROVIDE FOR THE CONSTRUCTION AND MAINTENANCE OF A CENTRAL HIGHWAY.

The General Assembly of North Carolina do enact:

SECTION 1. That there shall be established in the manner hereinafter provided a public Central Highway, extending from some point on Beaufort harbor, in the county of Carteret, through the counties of Carteret, Craven, Jones, Lenoir, Wayne, Johnston, Wake, Durham, Orange, Alamance, Guilford, Davidson, Rowan, Iredell, Catawba, Burke, McDowell, Buncombe and Madison to some point on the Tennessee State line. That the said Central Highway shall be composed as nearly as practicable of roads already existing; and the Highway Division of the North Carolina Geological and Economic Survey is hereby charged with the duty of selecting and designating the route of the said highway and to report the route so selected and the roads so designated to the board of trustees hereinafter provided for; and shall also report to the boards of commissioners of each county through which the said highway shall pass the route or line of road designated through such county. The duties imposed by this act upon the Highway Division of the North Carolina Geological and Economic Survey shall be considered as a part of its official duties, without additional compensation.

SEC. 2. That for the purpose of putting said Central Highway in order the boards of county commissioners of each county through which the said highway shall pass are hereby authorized and empowered to appropriate out of the general county funds a sum not exceeding fifty dollars ($50) for each and every mile of said highway in such county, and each city or town through which said highway may pass is likewise empowered to appropriate out of its general funds a sum not exceeding one hundred dollars ($100); but if such town shall have a population in excess of one thousand persons, as ascertained by the United States Census of one thousand nine hundred and ten, such town may, for such additional one thousand inhabitants as shown by said census, appropriate an additional sum of twenty-five dollars ($25) for each and every thousand of population in excess of one thousand. That all funds appropriated by any county shall be spent within said county and under the authority of the board of commissioners of said county; and any funds appropriated by any city or town shall be expended within the county in which said city or town shall be located, and under the authority of the board of aldermen or other governing body of such city or town.

SEC. 3. That in addition to the appropriations hereinbefore authorized the boards of commissioners of the counties through which the said Central Highway shall pass are hereby authorized and empowered to use the road force of such county, whether it be hired or convict, upon the said highway to such an extent as, in the opinion of the board, may be practicable. And where there be no road force in a county the supervisor of roads shall, as far as possible, use the means available in constructing and maintaining this said Central Highway, coöperating as far as practicable with the board of trustees hereinafter provided for.

SEC. 4. That there is hereby created a Board of Trustees of the Central Highway, to be composed of one (1) member from each county through which the said highway shall pass, who shall serve for a term of four (4) years from and after the first Monday in April, one thousand nine hundred and eleven, and until their successors shall have been appointed and have qualified. That the following named persons are hereby appointed members of the Board of Trustees of the Central Highway for a period of four (4) years from and after the first Monday in April, one thousand nine hundred and eleven, and until their successors shall have been appointed and have qualified, to wit: G. D. Canfield, of Carteret; William Dunn, of Craven; J. H. Bell, of Jones; J. F. Hooker, of Lenoir; G. C. Royall, of Wayne; James A. Wellons, of Johnston; Dr. J. M. Templeton, of Wake; Dr. A. Cheatham, of Durham; H. M. McIver, of Orange; Capt. S. H. Webb, of Alamance; Clem

G. Wright, of Guilford; H. B. Varner, of Davidson; P. B. Beard, of Rowan; R. R. Clark, of Iredell; R. L. Shuford, of Catawba; W. E. Walton, of Burke; W. T. Morgan, of McDowell; E. C. Chambers, of Buncombe, and Thomas J. Murray, of Madison. That the said trustees of the Central Highway shall be notified of their appointment and shall meet in the city of Raleigh, in the rooms of the Department of Agriculture, on the twentieth day of April, one thousand nine hundred and eleven, for the purpose of organization; and the Commissioner of Agriculture shall notify each member of the said Board of Trustees of the time and place of said meeting, and shall himself act as temporary chairman in calling together the Board of Trustees, and shall serve as such until a permanent chairman shall have been elected. And the said Board of Trustees at this meeting, or at any subsequent meeting, may appoint such local committees or boards of directors for all or any of said counties as it may think proper, and impose upon such local committees or directorates the duty of conferring with the boards of county commissioners and other road authorities in constructing and maintaining said highway in their respective counties. Said Board of Trustees is hereby authorized to appoint an executive committee of not less than three (3) members; and this executive committee shall have all such powers as the said Board of Trustees may confer upon it; and the Board of Trustees is authorized to repose in said executive committee all or any part of the powers vested in said Board of Trustees by this act. The boards of commissioners of each of the counties through which the said highway shall pass is authorized and empowered to elect a successor to the member of the Board of Trustees from such county in case a vacancy shall occur; and in case a vacancy shall occur before the expiration of the term of office of the member from such county, the board of commissioners shall elect a successor, who shall hold office for the unexpired term of such retiring member. On the first Monday in March, one thousand nine hundred and fifteen, and quadrennially thereafter, the board of commissioners of each county through which said Central Highway shall pass shall elect its member of the Board of Trustees of the Central Highway.

Sec. 5. That the Board of Trustees of the Central Highway and their successors in office shall constitute a body corporate and shall have power to solicit and accept gifts of money, machinery, road materials, labor, or other things of value to be used and expended by the said Board of Trustees, under the direction of the proper road authorities of the counties or townships, in establishing, maintaining and improving said Central Highway as a public thoroughfare for the free and perpetual use of the public; and it shall have power to use all gifts and donations in improving the said Central Highway without regard to the county or locality. It shall also encourage and stimulate public interest in the maintenance of said highway and send representatives before any board of commissioners or other governing body of any county, city, or town to ask for appropriations of money to be used in each county, and also to advise and recommend the holding of elections to vote special taxes to be used in the construction and maintenance of said Central Highway. It shall also have power to arrange with and authorize the donation and testing upon the said highway of any improved systems of road building or dressing. It shall also have power to designate one day in each year to be known as "Road Day," on which day voluntary contributions in labor or other things of value shall be accepted to the end that the funds regularly appropriated may be supplemented by the volunteer offerings of the people and by the volunteer work of those who prefer to contribute labor rather than money. The said "Road Day" need not be uniform throughout the State, but shall be uniform throughout each county.

Sec. 6. That the counties and municipalities authorized to appropriate funds for the construction and maintenance of said Central Highway under section two of this act are hereby authorized to make appropriations not exceeding the sums prescribed in said section each and every year hereafter, which sums shall be used in the improvement and maintenance of said Central Highway.

Sec. 7. That the Secretary of State is authorized and directed to have printed two thousand (2,000) copies of this act as soon as practicable after its ratification; and that twenty-five (25) copies of the same shall be furnished to the Register of Deeds of each county through which the said highway shall pass for distribution therein; ten (10) copies of the same shall be furnished each Senator and Representative from such counties; one thousand (1,000) copies furnished to the Board of Trustees of said Central Highway, and the remainder kept for public distribution.

Sec. 8. The members of the Board of Trustees shall not be considered to be public officers, and shall not be required to take an oath of office, and shall receive no compensation for their services out of any funds arising under this act; but any county, city, or town may provide for the payment of the necessary expenses of its own members of said Board of Trustees.

Sec. 9. The said Board of Trustees shall elect a secretary and a treasurer, or it may combine those duties and impose them on one person. Accurate accounts of all proceedings and of all receipts and expenditures shall be kept, and a report made to the Governor at the end of each calendar year.

Sec. 10. That this act shall be in force from and after its ratification.

Ratified this the 7th day of March, A. D. 1911.

According to this act a meeting of the Board of Trustees of the Central Highway was called by Major W. A. Graham, Commissioner of Agriculture, in the office of the Department of Agriculture, on Thursday, April 20, 1911. There were in attendance at this meeting, the following members of the Board of Trustees:

Carteret—G. D. Canfield, of Morehead City.
Craven—William Dunn, of New Bern.
Lenoir—J. F. Hooker, of Kinston.
Wayne—George C. Royall, of Goldsboro.
Johnston—James A. Wellons, of Smithfield.
Wake—Dr. J. M. Templeton, of Cary.
Durham—Dr. A. Cheatham, of Durham.
Orange—H. M. McIver, of Mebane, No. 4.
Alamance—Capt. S. H. Webb, of Mebane, No. 4.
Guilford—Clem G. Wright, of Greensboro.
Davidson—H. B. Varner, of Lexington.
Rowan—P. B. Beard, of Salisbury.
Iredell—W. L. Gilbert, proxy for R. R. Clark of Statesville.
Catawba—John Robinson, proxy for R. L. Shuford, of Hickory.
Madison—Thos. J. Murray. of Marshall.

The absentees were:

Jones—J. H. Bell, of Polloksville.

Burke—W. E. Walton, of Morganton.

McDowell—W. T. Morgan, of Marion, who telegraphed hearty coöperation, but was detained on business.

Buncombe—E. C. Chambers, of Asheville.

The first business was the election of officers for the Board of Trustees, and those elected were as follows:

H. B. Varner, of Lexington, Editor of *Southern Good Roads*, Chairman.

Edward E. Britton, of Raleigh, Secretary.

George C. Royall, of Goldsboro, Treasurer.

Central Committee: William Dunn, of New Bern; Dr. J. M. Templeton, of Cary; R. R. Clark, of Statesville; W. T. Morgan, of Marion; Thomas J. Murray. of Marshall; J. A. Wellons, of Smithfield, Secretary; H. B. Varner, of Lexington, Chairman *ex officio*.

The Trustees decided to make an investigation of the route of the Central Highway, and to try to arouse enthusiasm for the Highway in the various counties by making a trip to the counties and holding a good roads day meeting in each county, at which routes would be discussed and plans made for the construction of the Central Highway. The arrangements for this tour were left to the Central Committee.

On adjournment of the Board of Trustees, the Central Committee met and organized by electing H. B. Varner, chairman, and J. A. Wellons, secretary. This Committee arranged details as to the payment of expenses in conducting the preliminary campaign, and fixed the date for the opening of the campaign in the east as May 8th, the work in the west to be begun the first week in June.

The automobiles used in making the tour of investigation for both trips were furnished by the J. I. Case Company, of Racine, Wis., and Mr. William Dunn, of New Bern.

The itinerary of the preliminary tour was Morehead City, May 8th; New Bern, May 9th; Kinston, May 10th; Goldsboro, May 11th; Smithfield, May 12th; and Raleigh, May 13th. This itinerary was carried out. Mr. R. M. Phillips, of Greensboro, in commenting on the tour, states:

> "From Beaufort and Morehead City to Raleigh the Central Highway scout party literally ran through a flame of enthusiasm for the highway and left behind it an expressed determination that it shall be built. When once it is done an impetus will be given to good roads building that will sweep the State. It will prove to the people that they are not too poor to build roads, and that the quickest way to escape poverty and penury is to build them. And they will build them."

The following took part in the tour of inspection:

H. B. Varner, James A. Wellons, Dr. A. Cheatham, R. M. Phillips, William Dunn, Dr. J. M. Templeton, and Joseph Hyde Pratt.

The second tour of inspection went over the western portion of the Central Highway, extending from June 5th to June 10th, and began at Marshall, Madison County.

Those making this portion of the trip were H. B. Varner, William Dunn, James A. Wellons, Col. Fred A. Olds, Col. R. M. Phillips, and Joseph Hyde Pratt.

Stops were made and addresses delivered at Marshall and Hot Springs, Madison County; Asheville and Black Mountain, Buncombe County; Old Fort, Marion and Nebo, McDowell County; Morganton and Bridgewater, Burke County; Hickory and Newton, Catawba County; Catawba River Bridge, Mooresville and Statesville, Iredell County; Salisbury, Rowan County; Lexington and Thomasville, Davidson County; High Point and Greensboro, Guilford County; Burlington, Mebane and Graham, Alamance County; Chapel Hill and Hillsboro, Orange County; Raleigh, Wake County.

The Highway Division of the North Carolina Geological and Economic Survey has assisted the following counties in locating and constructing sections of the Central Highway:

Carteret, Craven, Lenoir, Wayne, Johnston, Wake, Orange, Alamance, Davidson, Catawba, Burke, McDowell, Haywood and Madison.

The Central Highway starts at Beaufort Harbor and two branches have been decided on, one starting from Beaufort and the other from Morehead City, but up to the present time work has only been done on the latter.

Leaving Morehead City on a shell road, the traveler soon strikes a hard smooth sand-clay road built within the past year. This road is in sharp contrast to the heavy sand roads coming into it on all sides. The work on this road will be continued until it reaches Newport, on Newport River, 8.6 miles, and the Craven County line, a distance of ten miles. It passes through some of the open pocosons and some of the heavily timbered cypress swamps of Carteret County.

From the Craven County line to New Bern, the county seat of Craven County, a distance of twenty miles, the road is now being constructed and is of sand-clay. It does not pass through as much swamp land as the road between Morehead City and the county line. Just before reaching New Bern, the road cuts through the old embankments that were built during the Civil War to protect the city. New Bern is at the head of navigation of the Neuse River and is delightfully situated on the peninsula between the Neuse and Trent Rivers.

From New Bern to Kinston, Lenoir County, a distance of thirty-five miles, the highway when completed will be a sand-clay road passing through Jasper and Fort Barnwell and crossing the Neuse River at Carmack's ford, and then following up the Neuse valley to Lenoir County.

From Kinston to Goldsboro, Wayne County, twenty-nine miles, via La Grange, the road was originally through an almost continuous stretch of deep sand which is now being replaced with a sand-clay road. Notwithstanding the great quantity of sand that seems to exist in this section, there is close by sufficient clay to make a good and satisfactory sand-clay road.

Leaving Goldsboro, the route to Raleigh, Wake County, twenty-nine miles, is via Princeton, Smithfield and Clayton, Johnston County, and Auburn and Garner, Wake County. The road is well graded nearly the whole distance from Smithfield to Raleigh, and will be a sand-clay road.

The next section of the Highway from Raleigh to Durham, Durham County, a distance of twenty-six miles, is located on a ridge and contains very little grade. The road has been relocated to eliminate grade crossings and several short and steep grades. In Wake County the road will be of sand-clay or gravel, and in Durham County it is macadam.

From Durham to Graham, Alamance County, two routes have been decided on, one via Hillsboro, the county seat of Orange County, and the other, via Chapel Hill, Orange County. At the present time the best route is by way of Chapel Hill. From Durham to the Orange County line the road is macadam, and from the line to Chapel Hill it is sand-clay.

As one leaves Chapel Hill and rides toward Saxapahaw, Alamance County, he realizes that he has entered the rolling and hilly country of the Piedmont plateau region. The highway, however, is well located, with no grades over four and one-half per cent. From Chapel Hill to Saxapahaw only a part of the road has been sand-clayed.

The other route from Durham to Graham is via West Durham, Durham County, University and Hillsboro, Orange County, and Mebane and Haw River, Alamance County. The road is macadam to within a few miles of the Orange-Durham line. Across Orange County to Mebane no work has been done on the highway beyond its location. When built, it will be largely a sand-clay road. From Mebane to Graham, but little work has been done on the highway.

On leaving Graham the traveler will find a splendid macadam road for a distance of fifty miles, passing through Burlington and Elon College, Alamance County, and Gibsonville, Greensboro, Jamestown, and High Point, Guilford County. At Greensboro, the county seat of

Guilford County, the Central Highway intersects the National Highway, and the two highways coincide as far as China Grove, Rowan County, sixty-two miles to the south. The macadam road between Greensboro and High Point, fifteen miles, has been treated with tarvia.

Soon after leaving High Point the highway enters Davidson County, where, however, but little work has been done in good road construction. The route through this county has recently been resurveyed, and the bad hills have been eliminated. The highway as constructed through Davidson County, will be principally of sand-clay.

The Yadkin River is crossed by a toll bridge, but plans are now under way to have a free bridge across this river. The steep ridge immediately beyond the bridge will soon be a thing of the past. A new location has been surveyed for the highway, and the new road should be ready by spring. For the next fifty to sixty miles the highway is in splendid condition, with smooth surface and easy grades.

At Salisbury the highway again becomes double track, one line going to Newton, the county seat of Catawba County, via Barber Junction and Statesville, the county seat of Iredell County, and the other via China Grove, Rowan County, and Mooresville, Iredell County.

From Salisbury to Landis the road is principally sand-clay and in splendid condition. Up to this point from Greensboro the highway has been the same as the National Highway. At Landis the highway turns to the west and the road is sand-clay and macadam to Mooresville and to the Catawba-Iredell County line. The Catawba River is crossed by a new iron bridge that is nearly seventy-five feet above the river. A road has recently been located from the bridge to Newton which eliminates all grades over five per cent. The surfacing material will be sand-clay.

From Salisbury to Newton, via Statesville, the Central Highway is macadamized as far as Statesville, and from that city to the Catawba River at Buffalo Shoals the road is either macadam or sand-clay. A splendid new iron bridge has been built across the river. From the river to Newton, the highway has been located but only partially constructed.

From Newton to Hickory the highway follows a ridge and is nearly level all the way. Through Newton and Hickory Townships, provisions have been made for finishing the highway at once and this will take it to the Burke County line. The highway has been located across the larger part of the county and a few miles of the road have been graded. The route is via Connelly Springs, Valdese and Morganton, Burke County. From the Burke County line across McDowell County to the top of the Blue Ridge at Swannanoa Gap, the route is via Nebo, Marion and Old Fort. Only part of the road has been located, this being in Marion and Old Fort townships. Only a few miles of this location has been constructed, about three to four miles in each township.

At Old Fort the highway begins to climb up the Blue Ridge and some of the most beautiful scenery along the whole route is from here to Asheville. The road, as surveyed, will pass Round Knob, at which place there has been installed a fountain which throws a stream of water one hundred feet high. The highway climbs the mountain to Swannanoa Gap, with a maximum grade of four and one-half per cent. This section of the road is now being built.

At Swannanoa Gap the highway enters Buncombe County, which is the banner county of western North Carolina as regards good roads. It has a first class macadam and sand-clay road extending all the way from the Gap to the Buncombe County line on the west, the highway passing through Ridgecrest, Black Mountain and Biltmore to Asheville. The highway follows rather closely the Swannanoa River, a most beautiful mountain stream.

The road from Biltmore to Asheville is one of some interest inasmuch as it was the first improved macadam road built in Buncombe County and was constructed under the supervision of the Asheville and Buncombe County Good Roads Association, which raised the money for the work by private subscription. Since that time this association has been constantly at work encouraging the improvement of roads in Buncombe County and western North Carolina, with the result that Buncombe County contains the largest number of miles of improved roads of any county in the western part of the State, and Asheville has become practically the hub of the good roads work in that section of North Carolina.

The route of the Central Highway from Asheville to the Tennessee line via Madison County, will be by Weaverville, Buncombe County, and Mars Hill, Stackhouse and Hot Springs, Madison County; but, up to the present time, it has been found impossible to provide for the construction of this route beyond Mars Hill, which has now been constructed, making a macadam and sand-clay road connecting Asheville and Mars Hill. The county is now considering a bond issue.

The Central Highway is also located via Haywood County and there is now completed a macadam road from Asheville to Waynesville, via Candler and Turnpike, Buncombe County, and Canton and Clyde, Haywood County. From Waynesville to the Tennessee line the highway follows the Pigeon River valley and gorge, and all streams have been bridged.

There is given below a brief summary of the work done on the highway as reported by the Trustees:

County	Miles of Highway	Amount Surveyed and Located	Amount Graded	Amount Surfaced	State Engineering Assistance	Private Subscription	$50.00 County Appropriation
Carteret	18	all	8	8	yes	all	no
Craven	50	all	9	9	yes	----------	no
Lenoir	27	all	----------	----------	yes	----------	no
Wayne	19	all	12	----------	yes	partly	no
Johnston	28	22	22	15	yes	do	no
Wake	26	all	all	----------	yes	do	no
Durham	20	all	(Note 1)	----------	no	----------	
Orange	14	all	(Note 2)	----------	yes	partly	no
Alamance	25	all	(Note 3)	----------	yes	do	no
Guilford	28	all	all	all	----------	----------	no
Davidson	30	all	3	2	yes	----------	no
Rowan	38	all	all	all	----------	----------	no
Iredell	19	all	all	all	yes	----------	no
Catawba	23	all	10	----------	yes	----------	no
Burke	22	4	0	----------	yes	----------	yes
McDowell	22	7	3	----------	yes	partly	
Buncombe	25	all	all	all	yes	----------	no
Madison	26	7	7	7	yes	----------	no
Haywood	31	all	15	15	yes	----------	no

1. All via Chapel Hill; all but 1½ miles via Hillsboro.
2. Ten miles via Chapel Hill; none via Hillsboro.
3. All via Saxapahaw; all but 7 miles via Mebane.

Suggested Road Legislation

There are several ways in which the State can assist its counties in road construction as follows:

ENGINEERING ASSISTANCE.

While some counties have provided competent road engineers to have supervision of the location, construction, and maintenance of their public roads, the majority have paid but little or no attention to the need of the employment of such engineers; consequently there is needlessly wasted each year in North Carolina a large amount of money that could readily be saved to the county if it was expended under the supervision of competent road engineers or superintendents. There is over $500,000 of revenue that has been raised for the maintenance and construction of public roads, that is expended in such a way that it does no good whatever to the road. Nearly all the Good Roads conventions and meetings that have been held in the State for the past three years have advocated the State giving engineering assistance to the counties. Resolutions in favor of this form of State aid have been passed, not only by the North

Carolina Good Roads Association, but by the North Carolina Press Association, the North Carolina Bankers' Association, and others.

A BILL TO BE ENTITLED AN ACT PROVIDING ENGINEERING ASSISTANCE TO COUNTIES IN HIGHWAY CONSTRUCTION.

The General Assembly of North Carolina do enact:

SECTION 1. In order to further the work of the Highway Division of the North Carolina Geological and Economic Survey in rendering road engineering assistance to the counties in the construction and maintenance of their public roads, there is hereby levied an annual tax of fifty cents per horse power on all motor driven vehicles, which tax shall be in lieu of all other taxes on automobiles, and shall be collected by the Secretary of State in the same manner as the present one dollar license fee is collected, and shall be in lieu of this license fee; and this tax, as collected, shall be deposited in the State Treasury to the credit of the North Carolina Geological and Economic Survey for the purpose of carrying out the provisions of this act, and to be drawn upon as directed by the Geological Board. Every voucher, before it shall be paid by the said board, shall be accompanied by an itemized statement of the account to be paid.

SEC. 2. Any county desiring engineering assistance from the North Carolina Geological and Economic Survey shall make application for such assistance on blanks specially prepared by the State Geologist, and any county through its county or road commissioners accepting such engineering assistance shall agree to carry out the instructions of the Highway Engineer of the North Carolina Geological and Economic Survey; and shall further agree to construct and maintain the roads according to instructions to be given by the said engineer. Engineering assistance shall also be furnished to the counties relating to the best kind of bridge to be built in connection with the improvement of any road, and any county or township that is contemplating the construction of a bridge to cost over five hundred dollars ($500) shall not let the contract for said bridge until the plans and specifications for said bridge have been approved by the North Carolina Geological and Economic Survey, and the final payment, equal at least to 20 per cent of the contract price, shall not be paid by the county or township officials until the construction of said bridge has been approved by the engineer of the North Carolina Geological and Economic Survey. The engineer of the North Carolina Geological and Economic Survey shall also furnish to the county or township commissioners having in charge the road work an estimate of what the proposed bridge should cost, and no bid shall be accepted by said commissioners in excess of the estimate made by the said engineer, except as herein provided. If no bid is received by said commissioners at or under the estimate made by the said engineer, the letting of the contract shall be readvertised, and, if no bids are then received at or under the estimate of the said engineer, the said commissioners can, with the approval of said engineer, accept a bid in excess of the estimate.

SEC. 3. That this act shall be in force from and after its ratification.

As will be noted from the above, the revenue necessary for giving the engineering assistance is to be derived from the tax on automobiles. At the annual meeting of the North Carolina Good Roads Association this question of revenue was very thoroughly discussed, and the automobilists present, who represented all parts of the State, were unanimously in favor of this bill, and were of the opinion that the tax upon automobiles should go for this purpose, and that if this was done, there would be little or no complaint from the automobilists on account of the tax.

STATE CONVICTS IN PUBLIC ROAD CONSTRUCTION.

Legislation relating to the use of the State convicts in public road construction is one that has also received practically the unanimous support of the State Good Roads Association and the unanimous support of the North Carolina Press Association at their 1912 meetings. This bill provides that all able-bodied convicts sentenced to the State Penitentiary shall be used on the public roads, except such as are required in connection with the work at the Penitentiary. This bill does not interfere in any way with the present county convict chain gangs. Each county will carry on its own convict system the same as before. The allotment of the convicts in connection with the county work is by the Geological Board, of which the Governor is chairman. It is undoubtedly the opinion and belief of a large majority of the people of North Carolina that the convict should not be considered a collateral of the State, out of which they shall try to derive as much revenue as possible with which to pay running expenses.

A Bill to be Entitled an Act Providing for the Working of State Convicts on the Public Roads.

The General Assembly of North Carolina do enact:

Section 1. That all convicts sentenced to State Prison who are not required in carrying on the work of the State Prison and of the State farm shall be used in working the public roads as hereinafter provided.

Sec. 2. The Superintendent of the State Prison shall allot the State convicts to work on the public roads as directed by the chairman of the State Highway Commission, if such office shall be created by the General Assembly, or, otherwise, by the Geological Board. When counties shall apply for State convicts to assist in the construction and maintenance of their public roads, preference shall be given to those counties which do not have a sufficient number of convicts of their own to warrant their maintaining a chain gang for public road work. When thus allotted to the counties for such work, the county receiving such convicts for road work shall pay the cost of guarding, feeding, and clothing the convicts, and this shall be done in a manner satisfactory to the Superintendent of the State Prison. Where it is considered advisable by the Highway Commission, if such commission has been established by the General Assembly or the Geological Board, the State convicts may be used in the construction of inter-county roads, and the cost of guarding, feeding, and clothing the convicts shall be paid by the Superintendent of the State Prison.

Sec. 3. This act shall in no way interfere with the present acts relating to the sentencing of prisoners to work on the roads, and which are now under the control of county authorities.

Sec. 4. This act shall be in force from and after its ratification.

STATE SECURITY FOR COUNTY ROAD BONDS.

Another way in which the State can very materially and advantageously assist the counties in the construction of their public roads is for the State to lend its financial support to the counties in obtaining money for the construction of public roads. The State, as we all know, can very readily borrow money at 4 per cent interest, while the county has to pay on an average at least 5 per cent on all the money that it borrows. It requires approximately 1 per cent per year on a forty-year loan to provide a sinking fund which, when put out at compound interest, will equal the principal of the loan. Thus any county issuing $100,000 worth of bonds would have to provide, besides the yearly interest, a sum equal to $933 per year, which, put out at 5 per cent interest compounded, would in forty years provide the principal of $100,000. The county, therefore, has to provide 6 per cent each year to take care of its bond issue. Now, the difference at what the State can borrow money (4 per cent) and the county (5 per cent)—*i. e.,* 1 per cent—will take care of the principal of any loan when it becomes due. If the State, then, would borrow money at 4 per cent and loan it to the counties at 5 per cent, the 1 per cent additional interest which the county would pay to the State would take care of the principal of the bonds issued by the State; and the counties after paying the 5 per cent interest semiannually for forty years would have provided the State with an amount sufficient to pay for the principal. This would mean that all the counties would have to look after would be the 5 per cent interest, and they would not be worried or bothered with the principal, as this would be taken care of by the State. By such a method the State would not have to advance any money on the principal or for interest, and would simply be taking advantage of its credit in borrowing money at 4 per cent and giving the counties the benefit of this. Those counties which have issued bonds and are paying interest and providing a sinking fund know that it takes approximately 1 per cent in addition to the interest to provide for the sinking fund.

FORESTRY

Examination of Forest Lands

The State Geological and Economic Survey makes a practice of examining forest lands for any and all forest owners of the State who may desire it, with the object of making recommendations for their better management. The general plan is for the owner of the lands to pay the actual traveling and other expenses incident to the examination, while the Survey pays the salary of the Forester. Usually an examination may be fitted in with some of the other work which the Forester has to do, thereby greatly reducing traveling expenses so that usually for a few dollars a man may secure expert advice on the best method of handling his woodland. In the case of public and educational institutions, where the tract examined may be used to demonstrate the value of proper management, or in cases where private individuals will guarantee to carry out the recommendations so that the area may be used to a certain extent as an experimental plot, the Survey often arranges to make the examination entirely free of any charge. On the other hand, when the examination is desired chiefly or only that the owner may make more money out of his timber without any thought of perpetuating the forest, in other words, where it is entirely a commercial proposition, the Survey usually declines to make the examination at all. There are many firms throughout the country which make a business of conducting such examinations and the State has no desire to compete with the private forester.

The Forester has made several examinations of forest and woodland in different parts of the State during the past two years. As the recommendations given to the owners of the properties examined are of general application to forest lands in the same region and occupying the same soil areas, extracts from reports on these examinations which should be of general interest are given here as applicable to a region rather than to a single tract.

The first report seems to deal with such an important phase of forestry, that of the care of city water supplies, that it is given in full. The question of stream pollution and the regulation of stream flow, in connection with the health of the people in our cities who are using water from the streams, is coming to occupy such a large share of attention both in the United States and Canada, that what is being done in our own State along these lines cannot fail to be of interest to the general public. The Geological Survey would be glad to extend its operations so that the watershed of every city water supply in the State could obtain technical advice on the care and forest management of the catchment area from which the water is collected. On a recent trip to Europe the Forester visited two of the largest waterworks systems in England, with the idea of getting suggestions which might aid in solving any problems along these lines which might have to be dealt with in North Carolina.

Report on the Asheville City Watershed.

The city of Asheville obtains its water supply from the head waters of the North Fork of the Swannanoa River. The intake is eight miles to the north of Black Mountain Station and is about sixteen miles from Asheville. A sixteen inch iron pipe takes the water from the intake to the city reservoir, which is on the mountain several hundred feet above the town.

General Description.—The watershed consists of from six to eight thousand acres, practically all of which is forest land. It is enclosed by some of the highest mountains in the State, Bull Head and Blackstock's Knob, Potato Top, Pinnacle and Graybeard,—mountains varying in elevation from 5,300 to 6,400 feet, all being on the divide. The greater part of the forest area is of the chestnut slope type, with chestnut, the oaks and poplar as the principal trees. Considerable timber of these species is found, though the best poplar, ash and other more valuable woods were cut off before the city purchased the land some ten or twelve years ago. On the high slopes and ridges are considerable areas of beech type, containing practically no merchantable timber. The spruce type covers the principal slopes of Blackstock's Knob and Potato Top, though on the latter mountain a good deal of the forest was destroyed some years ago by fire.

Object of the Owners.—The city of Asheville has steadfastly refused to have any timber cut from this area, and all their efforts are now bent toward the maintenance of this tract in the best possible condition for the protection of the water supply. Every care has been taken to keep out fires, and no serious fire has occurred since the city bought the property. No protective measures have been taken, however, other than unceasing watchfulness and frequent patrol. The city, however, is anxious to take further precautions to insure better fire protection if these are necessary and advisable, and it was for this purpose that the Forester visited the tract.

Fire Lines.—Owing to the proximity of lumbering operations which are now going on and are expected to continue for some years on the Connally lands, which join the property for two miles on its southern boundary, extra precautions seem advisable. No matter how careful those who conduct sawmills and logging operations may be, there is always considerable risk of fire getting out during the dry season. Should such a fire occur on the part of the tract nearest to the city property, it would be next to impossible to keep it from burning over to the watershed. For this reason, a fire line all along the southern boundary of the property, or at least that part of it that would be most subject to fire, is strongly advocated. A fire line should certainly be constructed from the creek up the ridge toward the top of Graybeard. At present, for a considerable distance along this ridge there is an old rail fence belonging to the Connally place, paralleling the wire fence constructed by the city. These two fences combine to collect a large amount of leaves all along the boundary which, together with the rail fence, are a continual menace to the State tract. A fire line on this part of the boundary should be made slightly to the north of the line, giving the cleared area which should be from twenty to thirty feet wide a slight slope towards the north. This would greatly assist in keeping it free from leaves and in stopping a fire should one occur. The rail fence should be removed from the boundary and the wire fence or at least the lower wires of it should be taken away, so as to prevent the leaves piling up. This line need not come quite to the top of Graybeard, but should come as far as there is any risk of the woods burning. Such a fire line is made by clearing off all the underbrush and young growth up to four or five inches in diameter for a width of fifteen to thirty feet, the greater width giving the better protection. The brush should be piled and burned, and the leaves raked from each side towards the middle, and burned when enough men are present to insure its not escaping. All down logs should be removed from this line, and all dead trees from which fire is liable to spread should be cut down and removed. This space, clear of leaves and brush, not only will stop a fire of itself in ordinary weather, but will, even in a high wind, form a place of vantage from which the men can back fire against an oncoming fire. Such a line should be constructed for from $40 to $60 a mile, varying according to the amount of brush and logs to be removed.

A fire line is also recommended along the western half of the south boundary. Adjoining the city property along this line is a tract recently cut over by the owner. A great deal of slash and other inflammable material is now on the ground, and should fire get into this nothing would be able to prevent its extending on to the city property. A fire line along the boundary, or perhaps, what would be better, along the ridge slightly to the north of the boundary, would make the tract much more secure against fire. This line, like the one on the south side of the valley, need not go to the top of the divide, as the slope of the mountain under the top of Bull's Head would not be very likely to burn over and the danger there is much less. The part of the boundary line running along the main divide from Bull's Head over Blackstock's Knob to Graybeard was not two years ago very subject to fire, and an expensive fire line along this ridge was not then advised. On certain parts of this, however, the weeds grow very dense, and would readily carry fire from the other side of the mountain on to the watershed. In these places it may be advisable to clear the weeds away and burn them as soon as they are killed by the first frosts, for a width of fifteen or twenty feet. There is practically no underbrush in these places, so that the cost of clearing such a fire line would be small.

All together about three miles of fire line, extending for a mile and one-half on each side of the creek, are recommended. This should not cost over $150 to $200, and could be supervised by the men now regularly employed on the property.

Trails.—It is strongly recommended that the trails now in use on the property be opened up and improved, to facilitate the patrol of the property and to act as fire lines in case of necessity. It is next to impossible for a man to make the full round of the property in one day on foot, but, if the boundary trails were passable for a horse, it would be easy, as much of the distance would be comparatively level. The trail from the intake to Peach Orchard Gap is now passable for a horse, but it could be considerably improved by reducing the grade in certain places. The trail from Balsam Gap over Blackstock's Knob is now impassable for a horse, and it seems very necessary that this should be opened up. It may be necessary for this trail to wind on to the adjoining tract, but no doubt the owners would be perfectly willing to have it made on their land, and they might even assist in its construction. From Potato Top to Graybeard a fair trail exists which is supposed to be kept up by the Montreat Association. This could be considerably improved, and it would be to the interest of the city to assist in its maintenance. From Graybeard to the intake a trail should be constructed as near to the boundary line as possible. The trail now in use goes through the Connally property at a long distance from the line, so that in fighting fire it would be of little use. With a trail along the fire line made passable for a horse, very thorough protection would be secured.

The present trails from the intake to Balsam Gap and Toe River Gap should be opened up and improved so as to be made passable for a horse. A trail up the dividing ridge between the two forks of the river, past the old "half-way-house" to the outside boundary of the property, should be constructed as this ridge is a point of vantage from which the whole property can be seen.

It might be though that improvement of the trails would encourage trespass, but it is believed that, by making it easier for the guards to get around, the liability of strangers coming in will be greatly diminished. The cost of new trails such as are suggested would range from $25 to $50 a mile, while the clearing up of the old trails can be done at a very small expense.

The Fences.—The whole property is surrounded by a barb-wire fence, which has been in use for several years. This was built for the purpose of protecting the area from stock. The fence has gotten in pretty poor condition owing to the decay of the posts, many of which are made from very poor material. If it is to be kept up extensive repairs will shortly be necessary. There seems, however, but little use for this fence, and it is recommended that it be taken down, especially the part along the south boundary. Buncombe County has had a stock law for many years. It is against the law for stock to run at large. It has been the policy of the city to fence against any stray stock, however, rather than to enforce the law, thinking that thereby they would retain the good will of the neighbors, which they seem to have done. Very little stock, however, is now running at large, and the time seems to have arrived for a stricter enforcement of the law. The aldermen might very well notify the neighbors that at a certain time, say twelve or eighteen months hence, the fence will be removed and that after that time the law will be enforced. This would give the neighbors time to get used to the idea of taking care of their own stock and give them no grounds for complaint.

The fence along the divide, especially that part of it on the Yancey County line, may be necessary till that county gets the stock law, though it is quite a question as to whether the danger from fire caused by it is not greater than the small risk of polluting the waters by a few stray cattle or hogs.

Auxiliary Intake.—The waters of the left hand fork of the creek are only used in times of dry weather when the main creek is not sufficient. This auxiliary intake, however, is situated some three quarters of a mile below the boundary of the city watershed, so that the waters taken to the city include much that is collected on land outside of the municipal control. On the Walker tract which adjoins the city property, a sawmill and logging camp has been used for some time, but is now abandoned. A very large pile of sawdust near the creek is gradually rotting, and the washings from around the camp go into the stream during heavy rains. This property should either be bought by the city and cleaned up thoroughly so as to insure both better fire protection and purer water, or the intake should be moved up the stream to the boundary line of the city property. The former is strongly advocated because of its value as a measure for fire protection.

Summary.—In order to further protect the city watershed from fire and to still further insure the purity of its water supply the following measures are recommended:

1. The construction of fire lines along the south boundary from the creek to near the top of Bull's Head and from the intake to near the top of Graybeard.
2. The cleaning up of a temporary fire line in certain places along the boundary line on the top of the main divide.
3. The construction of a trail passable for a horse all around the property, and the trimming up and improvement of the trails from the intake to Balsam Gap and to Toe River Gap; also the construction of

a trail from the intake along the middle ridge past the old "half-way-house" to the outside boundary line.

4. The removal of the wire fence from the south boundary, with adequate notice to the people of the neighborhood, and the removal of the fence from the whole of the boundary as soon as the stock law is enforced in the bordering counties.

5. The purchase and improvement of the Walker tract or, as an alternative, the removal of the auxiliary intake above the Walker boundary line.

Approved: J. S. Holmes,
Joseph Hyde Pratt, *Forester.*
State Geologist.

Care of Second Growth White Pine

White pine, perhaps the most valuable timber tree in western North Carolina, is rather restricted in its range. It is now found in mature virgin stands only in a few localities at short distances on either side of the Blue Ridge. Originally it was no doubt scattered through the hardwood forests on each side of the Blue Ridge throughout its length in this State, and it is in this belt that we now find the second growth stands. These second growth stands are largely restricted to land which at one time has been cleared and later abandoned, because it is in such situations that it has been protected from fire. Throughout the southern and eastern sides of the Valley of the French Broad such stands of second growth white pine can be found, usually on only comparatively small areas. A property of about 1,100 acres in this region was examined and the following recommendations were given for the treatment of the second growth white pine which had come up partly in the cut-over forest areas, but mostly on old fields. The soil was the gravelly and argillaceous clay of the type common in the plateau regions of the mountains. It was most of it comparatively poor, so that the area could be more profitably handled as forest land than for agricultural purposes.

REPORT ON THE STRUAN PROPERTY AT ARDEN, BUNCOMBE COUNTY, NORTH CAROLINA.

The Struan property is situated about two miles southeast of Arden, in Buncombe County, North Carolina. Near the center of this property is situated Christ School, a mission school founded by Rev. Thos. C. Wetmore, for the boys and girls of the mountain region of the State.

This property consists of about 1,100 acres of rolling land, most of which has at one time been cleared, but the greater part of it is now growing up to a second growth forest. The soil is a gravelly and argillaceous clay, of the type common in the plateau region of the mountains. Most of it is comparatively poor, and can probably be more profitably handled as forest land than for agricultural purposes.

It is for this reason that the owner wishes to improve the present stand and obtain the most rapid growth possible, that a perpeual income may be realized from the property.

The original forest growth consisted of the usual mixture of black oaks, white oaks, yellow poplar, chestnut, black gum, and other species, common to the region. Only a small portion of the tract, however, still remains in the original woods, and this has been so changed by periodical cuttings that the old growth is little more than black oak, black gum and other inferior species.

The remainder of the tract, with the exception of what is under cultivation, is the old field type common to the region, consisting chiefly of pitch pine and shortleaf pine, coming up gradually after the land was abandoned 30 or 40 years ago, with a younger growth of white pine started at a later date, and, on some of the richer southerly or easterly slopes, a considerable mixture of young yellow poplar.

The chief forest feature of the property and the one which constitutes its greatest value is the splendid stand of young white pine, of all sizes up to 10 to 12 inches in diameter. There is hardly a piece of woods without this excellent growth of white pine, even in the original forest growth the reproduction of this species is phenomenal, and it is only where fires have been frequent and destructive that young white pine can not be found.

The whole of this white pine growth seems to be primary and secondary reproduction from a few trees planted around the house for ornamental purposes probably one hundred years ago, by the present owner's grandfather. Seedlings from these trees have come up on various parts of the place, and are now bearing seed, and seedlings from them form dense stands over a large proportion of the tract.

A small sawmill, run by water-power, is being operated by the owners of this property, the timber manufactured by it being largely cut on the place. This is, however, supplemented to a small extent by logs brought in by the neighboring farmers. At present the remaining inferior oaks and the pitch and shortleaf pine are the principal timbers cut, practically all of the hardwoods being worked up into mission furniture in the woodworking shops of the school. It is the desire of the owner to gradually increase the proportion of white pine available till the output of the mill will be entirely of this species. In this way, it is hoped to largely increase the value of the output.

RECOMMENDATIONS.

As conditions seem so favorable to the growth of white pine and adequate reproduction is found over the larger part of the tract, the principal effort in management should be directed towards absolute prevention of fire and the cutting out of the inferior trees so as to give the white pine a better chance and to prevent the reproduction of the poorer species.

Fires have done enormous damage on a considerable area on the western side of the property, killing all the reproduction and seriously injuring or destroying the young growth and what mature timber was still on the ground. Young white pine and poplar are both easily killed by even light fires so that to procure reproduction of these two species fire must be absolutely prevented. The boys at the school are a continual menace, by the careless handling of matches and cigarettes around the school. The boys should be instructed as to the danger of fire and the injury caused by it. A good idea would be to organize them, if possible, into a fire-fighting force, giving them elementary instruction in the work they should do if a fire was to occur. This would not only make them more efficient fire-fighters, but would educate them in the first essentials of forestry.

Cutting should be done primarily with the idea of favoring white pine and also yellow poplar where that is present. The pitch pine should be cut as needed, wherever it is large enough. Where it and the shortleaf pine are mixed the superior shortleaf will benefit by the thinning, and room will be made for the growth of the white pine reproduction. Later on the shortleaf can be cut, leaving the white pine in full possession of the ground. The poor-shaped, forked, and otherwise inferior white pine that are large enough for lumber, may also be cut, provided they are not needed for seed trees, but in every case sufficient seed trees should be left. Even where the ground is fully occupied with white pine reproduction it is much safer to leave a few trees capable of bearing seed, so that in case fire should destroy the young growth there would still be an opportunity of reseeding.

September, 1911. J. S. HOLMES,
Forester.
Approved:
JOSEPH HYDE PRATT,
State Geologist.

Forests on the Stiff Red Clays

Throughout the Piedmont section of the State are considerable areas of what are known as stiff red soils, the so-called red clays derived from hornblende bearing rocks. These soils are usually free from stones and are quite fertile. As a consequence of this most of such land has been cleared up for agricultural purposes and in many places has subsequently been worn out and abandoned. As a result, many of the second growth shortleaf pine stands throughout the Piedmont region are found on these soils.

Where such land can be cleared up and used again for agriculture it will in most cases pay to do this. Much of the land, however, has been so badly eroded that it will probably yield better returns in the long run, to the owner, by keeping it in woods than by clearing and getting a few good crops with the risk of subsequent rapid deterioration from erosion. Two farms of this type of soil were examined, one towards the western limit of the region and one on the extreme eastern limit.

On the former tract the soil is, as a rule, of good quality readily susceptible of improvement, and, when cleared, yielding fine crops if properly handled. The land which is chiefly valuable for agriculture will be mostly cleared up and put in farm crops, while the areas which are rough and broken, and would be easily washed, may be kept permanently as a woodlot to supply the farm. Two considerable areas of woodland, representing two subtypes, occur on this farm.

Report on the Woodlands on the Farm of Dr. B. W. Kilgore, at Elmwood, Iredell County, N. C.

Dr. Kilgore's farm, which consists of about 1,100 acres, lies about one-half mile south of Elmwood in Iredell County. About 400 acres is cleared and largely cultivated, while the remaining six or seven hundred acres is mostly in second growth, forest or shortleaf pine and some other species. The woodland is cut up into areas of varying shape and size by the cleared fields. Only two of the principal areas were examined, as these were said to be typical; a third area, included in a pasture field, was also seen, but not carefully examined.

The soil is a good quality of red clay, readily susceptible of improvement and yielding fine crops when properly handled. There is a regular railroad station at Elmwood, it being located on the Western North Carolina branch of the Southern Railway. The Central Highway also runs through the village, and this road is being put in splendid condition. The road leading down to the farm, however, being little used except by the tenants on the property, has not been improved and in winter time is said to be very bad, making the hauling of wood to the station a much more difficult and expensive matter than it should be.

The owner wishes to handle his woodlands in the best possible way. The land which is chiefly valuable for agriculture will be gradually cleared up and put in farm crops, while the areas that are rough and broken and would be easily eroded, will be kept permanently as a woodlot to supply the farm.

An area of from 250 to 300 acres of rather open woods extends through the southwest corner of the place. It contains a stand of shortleaf pine of varying ages and sizes, some of it being now merchantable, while the larger part is not large enough for saw timber, though it could be marketed as cordwood. There is also considerable red cedar on the tract, which will be used for fence posts. In some places there are young yellow poplars and also some oak, hickory, and other hardwoods. There are no signs of recent fire through these woods, and there is a good coat of humus on the soil, with enough undergrowth to keep the ground in the best possible condition for the growth of trees. This land is all agricultural and is too valuable to keep permanently in forest. The owner proposes to clear off this area gradually, adding the parts first that are adjacent to the fields that he wants to enlarge. This is undoubtedly the best policy, for he not only can do the greater part of the work with the regular farm hands at spare times, but he will take advantage of the greatly increasing prices for lumber, cordwood, etc., and also be able to take advantage of the rather limited market. This area should stand just as it is until the owner is ready to clear it. The stand is plenty thin enough to make a good growth without further thinning, and it is thought that neither this nor any other operation can pay for itself in the short space of 10 or 15 years, in which time the owner expects to have it all cleared.

On the second tract the surface is much rougher, having been badly washed out after it was abandoned, before the present stand of timber occupied the ground. On this area is a second growth of shortleaf pine of all ages and sizes up to 15 to 20 inches in diameter. There is a considerable amount of merchantable saw timber and much more that, if given a good chance, would soon make timber. The reproduction of shortleaf pine is scattered over the area, though chiefly in the more open situations. There is some cedar and a few small hardwoods, chiefly the yellow poplar. This area it is proposed to keep permanently in forest, as the soil is poorer and the surface too rough to cultivate profitably. The owner proposes to cut out the larger timber and have it sawed for use on the farm or for sale. By doing this judiciously the forest can be considerably benefited. If only the trees, say above 12 inches, are taken, and the younger growth and reproduction saved as much as possible, the smaller trees will grow very rapidly and will furnish seed to seed up the areas now occupied by the mature timber on which little reproduction is now found. Care must of course be taken in felling, to injure the remaining trees as little as possible, and every precaution must of course be taken to keep out fires. The owner proposes to cut the timber himself, and then employ a sawmill man to log it and saw it. This is an excellent plan because it insures the cutting of only those trees that should be taken and the complete utilization of the timber. An area of 75 or 100 acres to the north and west of the former tract was gone through.

The following figures were given me by Mr. Pugh, who is in charge of the farm:

Firewood sells, delivered at the station, for $1.80 per cord of 128 cubic feet. It costs to put it there: Cutting, 50 cents; hauling, 50 cents; loading, 10 cents; leaving 70 cents for stumpage and the cost of overseeing the work. Pulpwood brings $4.00 per cord of 160 cubic feet, delivered at the station. The cost of cutting and peeling the wood is $1.50, and should be worth $2.00. Mr. Pugh contends that there is more money in selling firewood than pulpwood, though, in spite of the extra size of the pulpwood cord it would seem as if there was a larger margin of profit in the pulpwood. This is to a considerable degree offset, however, by the fact that only the less knotty parts of the tree can be used for pulpwood, while in cutting firewood all the tree is used. It would seem that the best plan would be to cut both kinds of wood where the timber will permit this, so that the larger amount may be marketed.

The cost of lumbering second growth pines is given roughly as follows:

Stumpage, $3.00 per thousand; cutting, logging, sawing and stacking, $5.00; hauling to the station from one-half to one mile, 50 cents. Lumber will bring, delivered on the track, from $9.00 to $10.00 per thousand, though one can not depend on getting more than about $9.00 per thousand log run. Should the owner cut his own logs and the mill man log, saw, and stack them, he will do this for $4.50 per thousand.

Finally, cutting on both areas will have to depend largely on the condition of the local market, care being always taken not to cut more than can be sold. It is thought that considerable money might be spent on the road from the farm to the railroad station with advantage and profit, for not only would the hauling bill be reduced but the owner would be enabled to put his material on the market when the demand was greatest and at the times when the farm work was least pressing. If the road was once rounded up and drained it could be kept in excellent condition by running a split log drag over it after each rain, which would not average over an hour's work per week for a man and team.

The yarding accommodations of the Southern Railway at Elmwood seem to be quite inadequate, so that hauling can not be done when the roads are good, as nearly all the cordwood shipped must go straight from the woods to the car. The Southern Railway might increase their yarding facilities if strong representations were made by the principal shippers from this station.

There is some woodland now fenced up and used, together with some open land, as pasture. This is bad for the growth of the trees, but under the circumstances it can not be avoided. The land is worth more for pasture than it is for growing timber, and the sooner the greater part of this timber is cut off the better it will be for the pasture, for grass and trees can not either of them grow to the best advantage on the same areas.

These woods were not visited, as they were regarded chiefly as pasture lands.

Approved: J. S. Holmes,
Joseph Hyde Pratt, *Forester.*
State Geologist.

The property examined on the eastern border of this red clay region offers some different types of forest and, consequently, different problems of handling. The following recommendations for the management of two woodland areas will be of general interest.

Report on an Examination of the Woodlands on the Berry Place, Orange County.

The whole place contains five or six hundred acres of land, about half of which is in woodlands. The larger part of the woodlands has never been cleared and now contains a mixed growth of oak, poplar, and hickory, while the old field is grown up to shortleaf pine and cedar. There is practically no merchantable pine on the place, but there are a large number of cedars suitable for making posts. The hardwood forests also contain considerable merchantable oak and poplar.

The various areas are here considered more in detail. The number of the woodlot corresponds to the same number on the accompanying plan.

1. The first area is an original forest of hardwoods on each side of a small stream (in the northeast corner of the farm). Probably 90 per cent of the merchantable timber is oak, about half or more of it being white oak. The undergrowth contains reproduction of the various timber trees, together with a large amount of small dogwood and cedar. It was roughly estimated by driving through one side of this area that 2,000 feet per acre of saw-timber could be cut. Only a small proportion of this saw-timber would be of the higher grades so that probably it would pay best to use it, or as much of it as is needed, for farm buildings, etc. The forest condition of this area would be improved by cutting the large over-mature trees, giving a chance for the young growth

to come on rapidly. However, when this is done, the dogwood should be cut as close as possible and used for firewood, as in many places it is too dense to allow the more valuable species to grow properly. By cutting out the cedar also for posts a better chance would be given for the more valuable hardwoods.

2. This is a small area of old field surrounded by cleared land. It will probably pay to cut off the small pine growth for firewood, and clear up this land to improve the shape of the field.

3. This is a small area of old field pine on the south side of the main road, containing only a scattered stand of small pines. A small part of this is washed quite badly, but the principal part of it could best be cleared up and cultivated with the adjoining field. This area has recently been burnt over, but none of the trees seem to have been seriously injured.

4. This is a small patch of pine and cedar on the top of a knoll. Unless this is too rocky it would probably pay to clear this up to improve the shape of the field.

5. This comprises the whole of the northwest corner of the place, on the west side of the Roxboro road. The second area has at one time been cleared, but has grown up to pine and cedar with a few scattered poplars here and there. The pine is not yet merchantable for lumber, though much firewood could be cut. A large number of cedar posts can be cut on this area without in any way injuring the growth of the pine. All of this land lies well, and could be cultivated easily if cleared. The pines, however, are growing rapidly and will bring in a small annual income as long as it remains in woods. It, therefore, seems advisable not to clear this land until it is needed for agricultural purposes. There are a few large poplars on the extreme western end of this area which could be cut at any time. It would probably pay to leave all the smaller, immature poplars, as they are growing very rapidly.

6. This area is a continuation of number 5, and could be treated in the same way. However, as it is contiguous to the cultivated field, it might be cleared up before the other, or as soon as it is needed.

7. This is a small patch of pines and cedars on the top of a knoll surrounded by cleared land. Unless this is too rocky or too much washed, it might with advantage be cleared up, unless it is considered too steep to cultivate with profit.

8. This small area of pines and cedars could well be cleared up and put in crops unless it is considered that it is too badly washed. This area of original hardwood forest contains a good growth of thrifty young poplar, oak and hickory. It is the most promising hardwood growth on the place and should be left in woods until it is absolutely needed for agricultural purposes. There are a few old, over-mature

trees in this woods that might be cut with advantage and used for lumber and firewood, but care should be taken in felling them not to injure the thrifty young poplars that are comparatively abundant on this area.

9. This small area of scrubby pine and cedars surrounded by cleared land, might be cleared up with advantage, provided, the gulleys do not prevent its use for agriculture.

10. This small area of pine and oak on the top of a knoll, on the eastern border of the place, is probably too rocky to cultivate profitably and so is best left in its present state. A few old, mature trees should be cut out, leaving the smaller pines and oaks to grow more thrifty.

11. There seems no reason why this small area of pines and cedars on the eastern border of the place, should not be cleared up to improve the shape of the adjoining field. There is considerable pine firewood on it and a good many cedar posts. If it is found that the area is too rocky to cultivate, the cedar might be cut out with profit, leaving the pine to develop.

12. This area of old field, to the north of the house and barns, contains a scattered growth of small pines and limby cedars. Parts of this area seem badly washed, but the greater part of it could be cleared up and used for agriculture as soon as it is needed. A good many cedar posts could be cut here, and the branches used to fill in the gulleys both of this area and in the field to the south of it.

13. This tract of oak and pine woods, on the south side of the Oxford road, was not visited, but from a distance there seems to be considerable firewood on it and some merchantable oak timber. It seems to be quite hilly, and probably will not need to be cleared for some time, unless a pasture is made on this side of the road.

14. This area of woodland, on the south side of the Eno River, is part of the home tract, but, on account of its location, will have to be managed somewhat differently. Part of it is old field which is starting to grow up to a scattered young growth of hardwoods and pines, of no present and little prospective value. The woodland, however, is original hardwood forest and contains a stand of somewhat over 2,000 feet per acre of mature and over-mature white oak, red oak, poplar, and hickory. The timber on this area is of slightly better quality than that on the other tract, though even here all the more valuable timber has been cut out. There is quite a bit of poplar, though even this is not of very good quality. A sawmill put on the river bank on the northeast corner of this area could probably get enough timber to cut to justify its being put here. The reproduction of young growth is thrifty and much of it of the more desirable species, so that when the older timber is cut the growth of the young trees would pay interest on the

land. The greater part of this area is rather too steep to cultivate properly and should be left in woodland, unless it could be kept in permanent pasture.

15. This area is nearly all rough and steep hill land, quite rocky, and unfit for agricultural purposes. It now contains a scattered stand of over-mature hardwoods, averaging perhaps 2,000 feet to the acre, of oak and poplar, with a few sycamore, hickory, and other trees along the river. This tract extends from the river at Berry's mill, to and across a creek, though beyond the creek the land occurs only in a very narrow strip. On the south side of E. E. Petty's place this strip widens out, and on the west end of it—which has been cleared—only a scattered growth of pine and inferior hardwood species occurs. Considering this tract as a whole, it is of very little value either held in connection with the farm or independently. The timber now on it is probably not worth over $2 to $4 per acre, and it will be some time before the young growth becomes merchantable even after the mature timber is cut. The most valuable timber is close to the river, but there is not much of this. As part of the farm, it is worthless, except for the timber which might be cut off at the present time, for much of it is so remote that timber trespass would be hard to prevent and protection from fire would be impossible.

Considering the place as a whole, the original forest which is hardwood, contains, on an average, about 2,000 feet of saw-timber per acre. This includes cull lumber, which could not be profitably marketed, but which would do very well for the construction of barns and outbuildings. No attempt has been made to estimate the number of cedar posts on the old field type, but there are no doubt enough to fence a large part of the farm. An idea of the number could best be obtained after a certain number of posts had been cut, and the area cut over estimated.

Forest Management on the Slate Soils

In the southern portion of the Piedmont region in this State is a large area of what is known geologically as a formation of crystalline schists and slates. The soils on this formation are usually shallow clays and stiff yellow loams, sometimes superficially sandy, derived from gray or yellow slates. This class of soil is usually confined to the more southern counties of this belt, namely Randolph, Stanly, Montgomery and Union. The topography of the district where such soil is found is simple, the surface nearly flat or gently rolling. Throughout, it is ill drained and the variation in the growth is incidental to the thoroughness of the drainage. As a rule, the forests on these lands are slow-growing on account of the infertile soil and the poor drainage.

An examination was made of a small tract of woodland in Randolph County, situated not far from Asheboro, the county seat. It is fairly typical of the forests of this region, so that with modifications, the recommendations may be applied to similar forests in these four counties.

Report on the Forest Property of Miss Julia A. Thorne, Asheboro, Randolph County, North Carolina.

This property consists of some 350 acres of woodland, situated about two miles south of Asheboro, in Randolph County. It lies close to the Aberdeen and Asheboro Railroad and is penetrated by one of the main roads leading south from Asheboro.

The soil is a light yellow, gravelly clay, and is naturally poor, making the larger part of the land of no immediate use for agriculture.

The owner is anxious to do what she can to improve the yield of the forest and make it a paying proposition.

The original forest on this tract was the mixed oak and pine type common to the region. This, however, has been so closely cut over that there is practically now no merchantable timber on the area. The present stand consists of the various oaks—post oak, black jack oak, Spanish oak, southern red oak, and white oak being the most abundant. Hickory, black gum, sweet gum, and some other inferior hardwoods are also found on the tract. Some small crooked, cull, shortleaf pine are scattered over the tract, with, in many places, a fair sprinkling of shortleaf pine seedlings, varying in size up to eight or ten feet in height.

There is considerable fine, young, oak growth, below merchantable size, which will form the next timber crop. In many areas the trees are close enough together to make the long, clear boles which are so desirable, but in the more open situations the trees are too limby to make the best quality of timber. It is in these latter places, however, that the shortleaf pine reproduction has the best opportunity. In the moister situations on the tract there is some sweet gum reproduction, and here and there a little yellow poplar and ash.

RECOMMENDATIONS.

On account of the excessively close cutting which the property has suffered, there is not enough timber left to make even the cutting of cordwood profitable, so that no cutting operations are recommended. There are some scattered, dead-topped, crooked and inferior trees, which might be removed at any time with benefit to the forest, but the cost of doing this would probably exceed what would be got for the wood, and so, for the present, it should not be done. In a few years time the young pine, which should be favored in every way possible, may demand the removal of some of the overshadowing trees. If this is necessary, however, it is probable that some judicious improvement cuttings may be made to pay.

The shortleaf pine which grows well on the tract, should be looked upon as the tree of the greatest value and all operations should have the object of substituting pine for the present slow-growing and comparatively inferior oak growth. Some of the oak, however, especially the white oak, has considerable future value and should not be despised.

The only active operations which are for the present advisable in the management of the tract, are those which tend to prevent forest fires. On account of the proximity of the railroad on one side and several rather irresponsible neighbors on the other side, the danger from fire is considerable. The owner's well known desire to keep fire off the tract and her good relations with the neighbors has helped to prevent fires. Several old roads through the property might be cleared and all inflammable material removed, thus making an effective fire line, though the risk of burning off these roads which are grown up with grass, without carefully responsible help, might be greater than leaving them in their present condition.

The owner was very anxious to do what she could towards securing the appointment of a fire-warden for her (Randolph) county thinking this would help her in the protection of her tract from fire. Under the present law, however, this is not possible. The passage of a more effective fire law and its strict enforcement would do more to assist the owner in protecting her property than any individual action that can be recommended.

Approved: J. S. Holmes,
Joseph Hyde Pratt, *Forester.*
State Geologist.

Natural Regeneration in the Level Pine Woodland

The greater part of southeastern North Carolina was at one time covered with a forest of longleaf pine. This has now largely been cut and has in many places been replaced with a second growth of loblolly pine. On some areas, however, such as the level, poorly drained soils in Columbus, Wayne, Pender, Duplin, Brunswick and other counties, longleaf pine is still struggling for a foothold, and competes, with considerable success, with the loblolly pine. The loams of level pine woodland, which are at present in most places, the debatable points between the longleaf and loblolly pines, are in certain sections largely occupied by the latter species. There is little mature longleaf pine now standing in North Carolina, but there are still enough trees to furnish seed for a second growth stand on many of the old, cut-over areas.

It was in such a situation that an examination was made of certain areas on a 50,000 acre tract of woodland, with the object of answering three practical questions for the assistance of the owner.

REPORT ON THE EXAMINATION OF THE FOREST LANDS OF THE BUTTERS LUMBER COMPANY, COLUMBUS COUNTY, NORTH CAROLINA.

Object.—The object of the examination was for the purpose of giving advice on three points connected with the management of the cut-over and timber lands of this company.

These three questions are: (1) Can the white sand ridges be reforested, and if so, how? (2) Could any of the young growth be thinned, and if so, to what extent? (3) Is the present practice of burning over the land annually as a means of protection, injurious from the standpoint of procuring a second growth forest?

Tract.—The lands of the Butters Lumber Company comprise some 50,000 or 60,000 acres of pine land and swamp land on both sides of the Lumber River in Columbus and Robeson Counties and extending into South Carolina. The property consists of more or less scattered tracts of from a few acres to several thousand acres in extent, interspersed with alien holdings, many of which are occupied by the owners or are in part farmed by renters. Probably half the area is swamp land, a part of which has already been cut over and the rest contains a varying stand of sweet gum, black gum, tupelo and cypress. The greater part of the pine land has already been cut over and supports either a scattered growth of cull, longleaf or loblolly pine trees, or in some cases a fairly dense stand of second growth loblolly pine.

The parts of the property visited were low pine lands within a few miles of the Lumber River, practically all of them cut over, interspersed with "bays," and with ridges of white sand here and there within a mile of the river.

Reforesting Sandhills with Longleaf Pines.—The lands which the company wishes to reforest artificially are comparatively narrow white sand ridges which are found (to the south of Boardman) near the river. These ridges at one time supported a good growth of longleaf pine timber, as is indicated by the remaining stumps. Since the removal of the timber, however, several years ago, no young pine has come up, and the only trees growing on the ridges are two species of scrubby oak. There is practically no ground cover, except here and there some moss, indicating the poverty of the soil which is almost pure sand. There is no humus in the soil and no leaves are on the ground, those that fall being blown away to the swamps on either side.

These ridges are too dry for the production of loblolly pine, but there can be little doubt that longleaf pine would do well on them, provided, it could once get a start. It is, therefore, recommended that longleaf pine be sown on small areas of this type as an experiment, different methods and different times of year being tried.

Sowing in seed spots will probably be the best way, as this takes less seed. One or more men provided with rakes and seed, should start on one side of the ridge and make rows of seed spots across to the other side. These spots should be from eight to ten feet apart each way. The seed is put in by making a place loose and rough with the rake, putting in eight to ten seed and covering them from a quarter to one-half inch deep with a rake. Such spots might be from six inches to a foot across. Firming these spots with the foot would probably assist the seed in germinating rapidly.

The late fall, in November or December, is probably the best time to put in the seed, but February or March may do equally well. The advantage of spring sowing is that there is less chance of the seed being destroyed by vermin. The seed, however, are self sown in the fall when the cones open, and germinate during warm spells in the fall and winter, so that under ordinary conditions this would probably be the best time to sow.

Another, and probably the cheaper method of sowing, would be to broadcast the seed at the rate of three or four pounds per acre and then cover with a straight tooth harrow. This could easily be done as the ground is loose and there is no ground cover. It might, however, involve even more expense when only a small area is to be seeded.

Although the whole county is under the stock law, there are still some hogs running loose, and signs of them were seen on the sand ridges that it is proposed to plant. These must be kept off the planted area, if possible, as they are most destructive to both the longleaf pine seed and seedling.

Thinning.—A small area of second growth loblolly pine in an old field on the property has been thinned, and to some extent pruned, as an experiment, and further thinning would be undertaken in other places, if advisable. The thinned stand is growing very rapidly; but, as the trees are rather too far apart, they are spreading out too much so that the timber produced will be short and limby instead of long and clear, as would be the case if the trees stood closer together.

No stands of young growth were seen that it was thought it would pay to have thinned. Only a few stands (of young growth) were dense enough to make ideal conditions, most of them having been kept from coming up dense enough by the annual forest fires. This brings up the third question.

Burning.—From the above it would seem that the frequent burning has prevented adequate reproduction of loblolly pine. This was evident wherever the Forester went. Only scattered stands were seen in the old fields and on cut-over areas where, but for the fires, dense stands of young growth would undoubtedly have come in. The areas which have reseeded to loblolly pine have scarcely anywhere a very good stand, and in many cases are not over one-tenth as dense as they should be. This is undoubtedly caused by fire, as seed trees are plentiful in most places. Very little small seedling reproduction of loblolly was seen.

In strong contrast to this are the areas on which longleaf pine seed trees are standing. On these lands scarcely any reproduction over six years old could be found, yet on most of such areas longleaf pine seedlings under that age are abundant, though frequent winter fires have passed over these lands. This goes to show that the hog is a more important factor in securing longleaf pine reproduction than is fire. Five or six years ago the stock law was passed and hogs were excluded from the open lands. As a consequence, longleaf pine seedlings are coming up everywhere where seed trees exist. The fires undoubtedly kill some of these seedlings, and retard the growth and seriously injure the rest, but the majority of longleaf pine seedlings seem able to withstand a winter fire.

What was seen on this tract would indicate that to secure loblolly pine reproduction it is essential that fires be kept out at least for several years or until the seedlings are large enough to withstand winter fires. It also shows conclusively that it is absolutely essential to exclude the hog where longleaf reproduction is desired.

It is, therefore, recommended that certain areas on which it is desired to secure loblolly pine reproduction be protected as much as possible from fire and be not burned over for several years. In this way the advantage of keeping out fire could be demonstrated. Small areas more or less protected by swamp land or by cultivated land, or roads, could be used for the experiment.

Every effort should be made to secure coöperation of the neighbors in protecting their own and the company's lands from fire. It is possible that some concessions might be made by the company to secure such coöperation. For instance, the company might give their tacit consent to allow cattle to run in the woods during the winter or all the time, provided no responsibility for damages done by the cattle to neighboring farms would be put upon the company. For this concession the neighbors might agree to guarantee that no hogs should run in the woods of the company, and should also agree to assist in keeping out fire. The company might declare that if any suspicious fire occurred on the lands of the company, the neighbors' cattle would be at once and permanently excluded. Certain modifications of this plan or entirely different arrangements looking to the same end might be entered into. It is certain that no measures of fire prevention which the company might undertake could be effective without the coöperation of the neighors.

J. S. Holmes,
Forester.

Approved:
Joseph Hyde Pratt,
State Geologist.

Forest Conditions of Piedmont North Carolina

The study of the timber resources of the State, begun in 1909 under the coöperative agreement with the U. S. Department of Agriculture (See pp. 55-58, Biennial Report 1909-'10) was continued in 1911. The three counties of Davidson, Forsyth and Stokes were examined, thus completing what might be called the western Piedmont region of the State.

Reports on all the counties in this region have been issued as Press Bulletins (Nos. 64-84, Timber Resources of .... County), which were widely published by the newspapers in that part of the State.

Owing to the absence of the Forester on leave during the summer of 1912, this investigation of the timber resources of the State was temporarily discontinued, to be taken up again as soon as time and money are available.

When the remaining part of the Piedmont region has been studied in this same way, which it is hoped will be in a year's time, a report for the whole of the Piedmont region will be prepared and published. This should comprise, besides the information already given to the press, a description of the remaining counties, an account of the principal wood-using industries of the region, especially furniture manufacturing, and brief recommendations for managing the more important types of woodland of the region.

In connection with the above study of the forest conditions of the Piedmont region, a special report was prepared for the Carolina and Northwestern Railway Company of the forest resources tributary to their lines in this State. Towards the expenses of this study they contributed $200, an amount sufficient to cover the cost of the preparation of the report.

This report, as is stated in the letter of transmittal, takes up the forest conditions of the North Carolina counties through which the Carolina and Northwestern Railway passes and of the other counties upon which it now draws or may in the future draw for its freight. In it estimates are given of the amount of standing timber over the various parts of the region to show the amount of forest products the railroad can depend upon, and also to show the necessity for the conservative exploitation and management of these forests.

The suggestions made in this report for the enlargement of the railroad business and the development of its traffic cover four separate lines, all more or less related to the forest conditions of the region. These are: (1) the construction of improved roads leading to the railroad, either by the railroad, by the counties interested, or by the two coöperating; (2) the introduction and encouragement of some wood-using industries; (3) the improvement of agricultural conditions and the development of the principal agricultural industries by the railroad; and (4) the adoption of a settled forest policy for the railroad looking to the permanent improvement of forest conditions and the increased yield of material which must be used by the various wood-using industries along its lines.

LOBLOLLY PINE.

Late in the fall of 1911 a coöperative arrangement was made with the United States Forest Service for the prosecution of a mill scale study of loblolly pine. The Coöperative Report on Loblolly Pine, which the Survey is soon to publish, was found to be deficient in up-to-date information about the amount and grade of lumber that could be cut from trees of different size and quality, and this study was to procure figures that would correct this deficiency. The entire expense of the study was borne by the Forest Service, except the time which the Forester could give to it, which was about one month.

The object of the study then, was "to collect data on second growth loblolly pine as a basis for (1) graded mill-cut tables for logs and trees of different diameters; (2) actual mill-cut (ungraded) and log-rule volume tables for trees of different diameters and heights."

After several mills, cutting this class of material, had been visited, it was decided to conduct this study at a certain mill in Gates County. The Forester, with an assistant who was employed locally, did the work in the woods, while the Forest Assistant of the Forest Service, Mr. W. D. Sterrett, assisted by an expert scaler, did the work at the mill. The trees were measured as they were felled by the loggers, and the logs measured and numbered at both ends. These logs were then followed through the mill, and an accurate account kept of the amount of lumber which was cut from them. Over 400 trees, or nearly 1,300 logs, were measured. These figures have been compiled by the Forest Service and will be published in the forthcoming report of the Survey. They will be of very vital interest to owners of woodland and to lumbermen in eastern North Carolina, in assisting them to decide on a policy of reforestation or proper management of their woodlands.

Chestnut Bark Disease

The spread of the chestnut bark disease throughout the New England and North Atlantic States, within the past few years has been watched with much concern by the timber owners of Western North Carolina. The standing chestnut timber in many of the states to the north of us has, over very large areas been practically wiped out, so that they are no longer taking preventive steps, but are using all their energies to find out a market for the dead and dying chestnut timber. Many of these states are spending large amounts of money in connection with the study and eradication of this disease, or else with the object of enlarging the markets for chestnut destroyed by it. Up to the beginning of 1912 the disease has extended as far south as middle Virginia, and the forests of this State were seriously threatened. In the spring of 1912 a bill was introduced into Congress to appropriate $80,000, to be expended by the Bureau of Plant Industry in studying and scouting for this disease, with the object of determining some method of controlling it. Feeling that North Carolina was vitally interested in this matter, the Forester to the Survey appeared with several others before the House Committee on Agriculture at Washington in behalf of this measure which became a law in August, 1912.

Immediately after the passage of this bill an invitation was issued by the Chief of Forest Pathology in the Bureau of Plant Industry to attend a conference in Washington to discuss ways and means for carrying out the purposes of this act. The Forester to the Survey attended this meeting as did also the Chief of the Division of Plant Disease of the State Agricultural Experiment Station at Raleigh. As a result of North Carolina's interest in the matter and following out the policy agreed upon at the Washington Conference, a tentative agreement was entered into between the Chief of Forest Pathology, Bureau of Plant Industry, Washington; the Chief of the Division of Plant Disease, State Agricultural Experiment Station, Raleigh, and the Forester of the State Geological and Economic Survey.

This agreement was substantially as follows: That the Chief of Forest Pathology should appoint at once a man to do scouting work and to assist the Chief of Plant Disease of the Experiment Station in research work. That later he would also appoint a second man to do scouting and mapping. That mapping work should be under the direction of the Forester, the scouting work under the joint direction of the Forester and the Chief of Plant Disease of the Experiment Station, and the research work under the direction of the Chief of Plant Disease. Should the Forester and the Chief of Plant Disease disagree on any point touching the work of the two men, the Chief of Forest Pathology would decide any point at issue. That the two men to be appointed should be mutually satisfactory to all the parties concerned and that they should be furnished headquarters by the Survey and by the Experiment Station, which two offices should furnish them necessary laboratory and office equipment and stenographic help. That the Chief of Forest Pathology will pay the salary and traveling expenses of both men, and will also furnish them special equipment such as that usually furnished for scouting in this work. That all reports by the two men are to be made in triplicate so that each office concerned should receive a copy. That publications may be issued by any of the three coöperating parties as may be agreed upon later, provided the fact and nature of the coöperation is clearly set forth in the publication. That if the results of the scouting work appear to all three coöperating parties to justify the effort, the proper authorities in North Carolina will endeavor to secure an appropriation and undertake the destruction of diseased trees, but, that in any case, the United States Department of Agriculture, of which the Division of Forest Pathology is a part, having no State police authority shall be in no way responsible for cutting out work, or other preventive measures involving the destruction of private property.

In accordance with this agreement the Chief of Forest Pathology appointed Mr. Stephen C. Bruner, of Raleigh, in the latter part of September to do scouting work and assist the Biologist in research work. Mr. Bruner took the field about the middle of October, and spent two months scouting through all the northwestern counties of the State and collecting specimens of different fungus diseases, which he will later study in the laboratory of the Agricultural Experiment Station at Raleigh.

On November first the Chief of Forest Pathology appointed a second man, Mr. P. L. Buttrick, of New Haven, Connecticut, to assist in this work. After a week's preliminary study under the direction of the Chief of Forest Pathology, Mr. Buttrick started scouting in the southwestern counties of North Carolina, and at the end of November was still engaged in this work. He will probably finish the preliminary scouting covering all the counties south of the Southern Railway and west of Asheville by January 15th. The more detailed mapping work, it is expected, will be taken up in the spring of 1913 by both of the men.

No sign of the virulent disease which has caused the destruction of so much timber further north has so far been found in this State, but a modified form of it, usually known as the inactive endothia, is common throughout the region. This form is being carefully studied by the

Biologist of the Experiment Station. This study has been planned on broad lines, and the results, it is confidently expected, will be of great value to lumbermen, timber owners, and timber users throughout the hardwood region of the State. These results, the Survey is planning to publish as an Economic Paper on the Chestnut in Western North Carolina.

Addresses on Forest Management at Farmers' Institutes

In advocating the better management of forest lands, it is, of course, most necessary to reach the owners of that land. In spite of the fact that large tracts of timberland, both in eastern and western North Carolina are still held by lumbermen and speculators, it is nevertheless true that the farmers own by far the greater part of the woodland of the State. It is therefore essential that not only recommendations for the handling of woodlots, but also rules for logging timber areas and suggestions for making contracts for the sale of standing timber be given direct to the farmers and impressed upon their minds.

For this reason the Forester to the Survey has taken every possible opportunity of getting in contact with the farmer.

Through the courtesy of the State Department of Agriculture, though largely at the expense of the Survey, the Forester has each summer joined one of the Farmers' Institute parties in the western part of the State, and has made talks on improved forest management. From one-third to one-half of the average farm in North Carolina is in woods, and yet that part of the farm has, up till quite recently, been absolutely ignored when advocating better farm management. The yield from the woodland can be increased with improved methods just as easily as can the yield from the cultivable land or from the pasture. It is just as important, therefore, for the farmer to have expert advice on how to grow and sell his timber to the best advantage as on how to improve his soil or market his apples, or any other operation which has to do with the management of his business, which is making the most profit from the capital which he has invested. There should be a talk on some phase of forest management, such as "Securing the Second Crop," "Protecting the Woodlands from Fire," "Selecting Seed Trees," "Thinning the Woodlot," "Selling Timber," "Protecting the Young Growth from Stock," "Improving the Stand," "Cutting Timber," etc., at every Farmers' Institute held in this State. Unfortunately the appropriation of the Survey is quite inadequate for this, the Forester having been able to attend only a very small proportion of those Institutes held yearly in this State.

To show the importance of this work, and give some idea of the large number of farmers, and farmers' wives, sons and daughters, who are directly reached in this way, and the advantage of extending this phase of the work, the following figures are given for the two trips made by the Forester in 1911 and 1912 in company with one of the Farmers' Institute parties. Owing to the Forester's absence in Europe during August, the number of meetings attended the past year was less than formerly.

	1911.	1912.
Number of counties visited	12	6
Number of institutes attended	19	9
Number of addresses made	23	10
Total number of men and boys addressed	1,093	292
Total number of women and girls addressed	72	100
Average number hearing each address	50	39

The counties visited in 1911 were: Madison, Haywood, Jackson, Macon, Swain, Graham, Cherokee, Clay, Transylvania, Henderson, Polk and Gaston. Those visited in 1912 were: Caldwell, Avery, Watauga, Ashe, Alleghany and Guilford.

The Forester has made the following special addresses:

June 13, 1911. At Winston, N. C., before the North Carolina Good Roads Association, on and relative to good roads and forestry.

October 26, 1911. At Norfolk, Va., before the North Carolina Forestry Association, on forest fire prevention, and the objects of the North Carolina Forestry Association.

November 25, 1911. At Charlotte, N. C., at a special meeting held under the auspices of the North Carolina Forestry Association. He discussed the question of exterminating the pine bark beetle and assisted in the organization of the Mecklenburg Pine Beetle Association.

December 5, 1911. At Gastonia, N. C., he made an address on the pine bark beetle and organized the Gaston County Forest Association.

February 2, 1912. At Raleigh, N. C., the Forester made an address at the annual meeting of the North Carolina Forestry Association on the chestnut bark blight.

October 8, 1912. At North Wilkesboro the Forester made an address on protection of forests from fire and assisted in the organization of the Wilkes County Forest Protective Association.

October 24, 1912. At Charleston, S. C., before the North Carolina Pine Association, the Forester made an address on forestry for the eastern North Carolina lumbermen.

November, 1912. At High Point, N. C., before the Southern Furniture Manufacturing Association, the Forester made an address on the work of the North Carolina Forestry Association.

The Forester made several inspection trips which included the inspection of some insect-infected pine timber near Charlotte, N. C. This work was done with Dr. A. D. Hopkins, United States Department of Agriculture, in June, 1911.

At the request of the Butters Lumber Company the Forester visited their property at Boardman, N. C., in March and made suggestions on securing reproductions of thinning certain areas.

In conformity with an agreement entered into between the Survey and the Office of Silvics, United States Forest Service, he spent the month of January in Eastern North Carolina assisting Mr. W. D. Sterrett of the Forest Service in a mill scale study of second growth loblolly pine. This study was undertaken primarily to complete some tables in Ashe's report on the loblolly pine, which is to be published by the Survey. Several mills were visited in the northeastern part of the State, chiefly in Bertie, Halifax, Hertford, and Gates counties. The mill operations of Lyon & Dennis, of Suffolk, Va., were selected as being most suitable for this study. The mill is situated on the A. C. L. Railway at Gates, and a dummy runs over five miles to where the timber is cut.

Co-operation with Forestry Association

In line with the Survey's policy of interesting the people of the State in the subject of conservation of our natural resources, a Forestry Convention was called by it in January, 1911, to meet in Raleigh on February 1st, for the purpose of interesting the people in the proposed legislation for the protection of the forests from fire and other purposes along the line of forest protection. This convention was presided over by the State Geologist and resolved itself into a permanent association, adopting the name of the North Carolina Forestry Association. As this association was, in large part, the result of the campaign for forest protection which the Survey has carried on for many years, and as the Forester of the Survey was elected and has since been reëlected Secretary of the Association, the Survey and the Association have worked in close coöperation ever since the latter was started. The work of the association is almost entirely educational, and so is carrying out one of the principal objects for which the Survey was founded. The Survey, therefore, considers the association a medium through which it can carry on its educational work. For this reason, it has published the proceedings of the two annual meetings of the association as economic papers and press bulletins, realizing that these will have considerable educational value along forestry lines.

This Association appointed a legislative committee, which investigated, with the Survey, the question of legislation that seemed most desirable for the protection of the forests from fire. The report of this committee was submitted to the Convention held in Raleigh, February 21, 1912, and the following suggested legislation was endorsed by the Association:

A Bill to be Entitled an Act to Protect the Forests of the State From Fire.

The General Assembly of North Carolina do enact:

Section 1. That the State Geological Board shall appoint a technically trained and experienced forester as a member of the staff of the North Carolina Geological and Economic Survey, who shall be called the State Forester. He shall hold office at the pleasure of the Geological Board and shall receive such salary as the said board may direct.

Sec. 2. The Forester of the North Carolina Geological and Economic Survey shall be *ex officio* State Forest Warden and shall receive no additional compensation therefor, but shall receive his necessary traveling and other expenses as required under this law, to be paid in the manner provided for in section eighteen.

Sec. 3. The State Forester, as State Forest Warden, shall have supervision of township and district forest wardens, shall instruct them in their duties, issue such regulations and instructions to the township and district forest wardens as he may deem necessary for the purposes of this act, and cause violations of the laws regarding forest fires to be prosecuted.

Sec. 4. The State Forester may take such action as he may deem necessary to provide for the prevention and control of forest fires in any and all parts of this State, and he is hereby authorized to enter into an agreement with the Secretary of Agriculture of the United States for the protection of the forested watersheds of navigable streams in this State.

Sec. 5. The State Forester may appoint, with the approval of the Geological Board, one township forest warden and one or more district forest wardens in each township of the State in which the amount of forest land and the risks from forest fires shall, in his judgment, make it advisable and necessary.

Sec. 6. Forest wardens shall have charge of measures for controlling forest fires; shall make arrests for the violation of forest laws; shall post along highways and in other conspicuous places copies of the forest fire laws and warnings against fires which shall be supplied by the State Forester; shall patrol during dry and dangerous seasons under the direction of the State Forester, and shall enforce the laws, and shall perform such other duties as shall be considered necessary by the State Forester for the protection of the forests from fire. The township forest warden of the township in which a fire occurs shall within ten days make such report thereof to the State Forester as may be prescribed by him. Each district forest warden shall promptly report to township wardens any fire in his district.

Sec. 7. Any person who shall maliciously or willfully destroy, deface. remove, or disfigure any sign, poster, or warning notice, posted by order of the State Forester, under the provisions of this act or any other act which may be passed for the purpose of protecting the forests in this State from fire, shall be guilty of a misdemeanor, and upon conviction shall be punishable by a fine of not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days.

Sec. 8. Forest wardens (and deputy forest wardens) shall prevent and extinguish forest fires in their respective townships and enforce all statutes of this State now in force or that may hereafter be enacted for the protection of forests and woodlands from fire, and they shall have control and direction of all persons and apparatus while engaged in extinguishing forest fires.

Any forest warden may arrest, without a warrant, any person or persons taken by him in the act of violating any of the said laws for the protection of forests and woodlands, and bring such person or persons forthwith before a Justice of the Peace, or other officer having jurisdiction, who shall proceed without delay to hear, try and determine the matter. During a season of drouth the State Forester may establish a fire patrol in any township, and in case of fire in or threatening any forest or woodland the township or district forest warden shall attend forthwith and use all necessary means to confine and extinguish such fire. The said forest wardens may destroy fences, plow land, or in an emergency set back fires to check any fire. They may summon any male resident of the township between the ages of eighteen and forty-five years to assist in extinguishing fires, and may require the use of horses and other property needed for such purpose; any person so summoned, and who is physically able, who refuses or neglects to assist or to allow the use of horses, wagons, or other material required, shall be liable to a penalty of not less than five dollars nor more than fifty dollars. No action for trespass shall lie against any forest warden or person summoned by him for crossing or going upon lands of another in connection with his duties as forest warden.

Sec. 9. Each township forest warden shall be paid by the Geological Board, out of funds hereinafter provided for, at the rate of ten dollars a year, and each district forest warden at the rate of five dollars a year. Said sums shall be in lieu of all allowances for making reports, for postage, and for posting fire warning notices. For special services in investigating fires and the causes thereof, for patrol and for all time spent in actual fire fighting, forest wardens and district forest wardens shall receive compensation from the Geological Board at the rate of twenty cents per hour for the time actually engaged in the performance of their duties and reasonable expenses for equipment and transportation incurred in fighting or extinguishing any fire according to an itemized statement to be rendered the State Forester and approved by him. Forest wardens shall render to the State Forester a statement of the services rendered by the men employed by them or their district wardens, as provided in this act, within one month of the day of service, which said bill shall show in detail the amount and character of the service performed, the exact duration thereof, the name of each person employed, and any other information required by the State Forester. All accounts of the forest wardens (and district forest wardens) must be duly sworn to before a justice of the peace, notary public or other officer qualified to witness such papers within the county in which the expense was incurred. If said bill be approved by the State Forester, it shall be paid by the direction of the Geological Board out of funds hereinafter provided for.

Sec. 10. All persons, firms, or corporations operating any railroad, logging road, or tramroad through woodland within this State shall keep their right of way cleared of all combustible material by burning or other method: *Provided*, that where the right of way exceeds a total width of two hundred (200) feet it is not required to clear such right of way for more than a horizontal distance of one hundred (100) feet from the outside rail on each side of the track. Combustible material referred to in this act shall be construed to mean only such brush, grass, leaves, or other material that would ordinarily become ignited from a spark from the engine: *Provided*, that this section shall not be construed to prohibit or prevent any railroad company from piling or keeping upon the right of way cross-ties or other material necessary in the operation or maintenance of such railroad, or materials intended for shipment over such railroad. Nor is it intended to require the removal of buildings, fences, or other necessary or valuable improvements from the railroad right of way: *Provided, further,* that the notice to the adjoining landowners required by section thirteen of this act shall not apply to any burning necessary to carry out the provisions of this section.

Sec. 11. All persons, firms, or corporations operating locomotives, logging engines, portable engines, traction engines or stationary engines in or near woodland, and using fuel other than oil, shall see that all such engines are provided with adequate spark arresters kept in constant use and repair. All persons, firms, and corporations using locomotives and logging engines shall see that such engines are provided with dampers or nettings at both ends of their ash pans. They shall inspect each of their locomotives at least once every thirty (30) days and shall make records as to the condition of the spark arresters and other devices for preventing fires; such records shall be open to inspection by the State Forester or his deputies at all times, and all spark producing engines within the State may be inspected by the State Forester or by his deputies at all times when not in actual service.

Sec. 12. When engineers, conductors, or trainmen employed by any railroad, tramroad, or logging road discover that fences or other material along the right of way or woodland adjacent to the railroad are burning or in danger from fire, they shall report the same promptly at the next telegraph or telephone station at which the train is scheduled to stop, or at any other stops necessary in the operation of the train, or to section men along the line. The reporting of such fires shall not be construed to mean that the railroad companies making such report are responsible for such fires, nor shall such report be used as evidence in a suit arising from such fire, but is simply for the purpose of giving information as to the existence of a fire. Railroad companies shall give instructions to their section foremen for the prevention and prompt extinguishing of fires originating on their right of way, and they shall cause warning placards, furnished by the State Forester, to be posted at their stations in the vicinity of woodlands. It shall be the duty of every section foreman employed by any railroad company operating in this State, upon the discovery of any fire in the section under his jurisdiction, to summon necessary assistance, proceed to the fire and extinguish it.

Sec. 13. If any person shall intentionally set fire to any grass land, brush land, or woodland, except it be his own property, or in that case without first giving notice to all persons owning or in charge of lands adjoining the land intended to be fired, and also taking care to watch such fire while burning and taking effectual care to extinguish such fire before it shall reach any land near to or adjoining the lands so fired, he shall for every such offense be guilty of a misdemeanor and shall be fined not less than ten dollars nor more than fifty dollars or imprisoned not exceeding thirty days. This shall not prevent action for damages sustained by the owner of any property from such fires.

Sec. 14. Any wagoner, hunter, camper, or other person who shall kindle a camp fire or shall authorize another to kindle such fire, unless all combustible material for a space of ten feet surrounding the place where said fire is kindled has been removed, or shall leave a camp fire without fully extinguishing it, or who shall accidentally or negligently, by the use of any torch, gun, match, or other instrumentality or in any manner whatever, start any fire upon any grass land, brush land or woodland, without fully extinguishing the same, shall be guilty of a misdemeanor and upon conviction shall be punishable by a fine of not less than ten dollars nor more than fifty dollars or imprisoned not exceeding thirty days.

Sec. 15. All persons, firms, or corporations who shall burn any tar kiln or pit of charcoal or set fire to or burn any brush, grass, or other material, whereby any property may be endangered or destroyed, shall keep and maintain a careful and competent watchman in charge of said kiln, pit, brush, or other material while burning. Any person, firm or corporation violating the provisions of this section shall be punishable by a fine of not less than ten dollars nor more than fifty dollars or imprisoned not exceeding thirty days. Fire escaping from such kiln, pit, brush, or other material while burning shall be *prima facie* evidence of neglect of these provisions.

Sec. 16. For the purposes of this act woodland is taken to include all forest areas, both timber land and cutover land, and all second growth stands on areas that have at one time been cultivated.

Sec. 17. No action shall be brought against any person, firm, or corporation to recover damages from fire unless written notice of the claim is given to such person, firm, or corporation within thirty days after the fire, specifying in a general way the location of the damaged area and the nature of the claim that is to be instituted.

Sec. 18. The sum of twenty thousand dollars ($20,000) annually is hereby appropriated out of any moneys in the treasury not otherwise appropriated, for the purpose of carrying out the provisions of this act, the same to be drawn upon as directed by the Geological Board.

Sec. 19. That all laws and clauses of laws in conflict with this act are hereby repealed.

Sec. 20. That this act shall be in force from and after its ratification.

The Association also considered the question of endorsing a stock law, and recommended the following legislation regarding a State-wide stock law.

An Act to Protect the Landowners of the State From Loose Stock.

The General Assembly of North Carolina do enact:

Section 1. That from and after the first day of February, one thousand nine hundred and fourteen, the stock law shall be and hereby is established in all those parts of the State which are not now under the operation of this law.

Sec. 2. That it shall be unlawful for any stock to run at large in this State except it be confined to the lands of its owner, and that any person knowingly permitting his or her stock to run at large, except on his or her own lands, shall be guilty of a misdemeanor, and fined not exceeding ten dollars for the first offense and twenty-five dollars for the second or other offenses: *Provided,* it may be lawful for the owners of land or lands within this State to give a written consent or permission for other stock than his own to be run or be pastured on his lands, if confined to the same.

Sec. 3. That upon the written application of a majority of the qualified voters in any county, township, district, territory or well defined boundary, made to the board of county commissioners at any time, setting forth that the citizens of said county, township, district, territory or boundary are desirous of being released from the laws governing said stock law territory, it shall be the duty of said commissioners to submit the question of "no stock law" or "stock law" to the qualified voters of said county, township, district or territory, and if at any such election a majority of the votes cast shall be against stock law, then the said county, township, district or territory shall be released and free from the operation of the stock law.

SEC. 4. That the exemption from stock law authorized by section three of this act shall not be in force until a fence shall have been erected around such "no stock law" territory, with gates on all public roads passing into and going out of said territory: *Provided,* all streams which are or may be declared to be lawful fences shall be sufficient boundaries, in lieu of fences: *Provided, further,* no fence shall be erected along the boundary lines of any county, township, district or territory where the "no stock law" prevails.

SEC. 5. That for the purpose of building fences around such "no stock law" territory provided for in this act, the board of commissioners of the county may levy and collect a special collection upon all real property taxable by the State and county, within the county, township, district or territory which may adopt the "no stock law," but no such assessment shall be greater than one-fourth of one per centum on the value of said property.

SEC. 6. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 7. That this act shall be in force from and after February first, one thousand nine hundred and fourteen.

HYDROGRAPHY

During the past two years twelve gaging stations have been maintained in North Carolina by the United States Geological Survey and individuals. The daily gage readings of the height of the water in the streams at the points where these stations are located and the discharge measurements, which have been made and which give the actual amount of water passing the station each minute, will be published in Economic Paper No. 33. There were formerly thirty gaging stations maintained in North Carolina by the United States Geological Survey and the North Carolina Geological and Economic Survey, but, owing to the many demands made on the Survey for other forms of work, it was necessary to give up the coöperation in this work. The statistics relating to the water powers are published in Bulletins Nos. 8 and 20.

SWAMP LANDS AND DRAINAGE.

The General Assembly of North Carolina amended the Drainage Law and in a way that it is believed will make it much more effective. New drainage districts are constantly being organized and there are now 40 districts organized or in the process of organization. The names of these districts, their approximate acreage, and present condition are given below:

DRAINAGE DISTRICTS IN SWAMP AREAS.

NAME OF DISTRICT	COUNTY	NO. OF ACRES	PROGRESS OF DISTRICT
Broad Creek Drainage District	Beaufort		completed.
Conaby Creek Drainage District	Beaufort	27,000	organized and at work.
Pantego Drainage District	Beaufort and Hyde	30,000	completed.
Pungo River Drainage District, No. 1	Beaufort	27,000	organized and at work.
Buckle Swamp Drainage District	Bladen	1,222	organized.
Turnbull Swamp Drainage District	Bladen	3,000	petitioned for.
White Marsh Drainage District	Bladen		fallen through.
White Oak Swamp Drainage District	Bladen		petitioned for.
Cape Fear River & Lyon Swamp Drainage District	Bladen and Pender	18,000	completed. (cost $43,577).
Old Rice Lands Cotton Plantation	Brunswick	17,400	petitioned for.
Camden Run Drainage District	Camden and Currituck	24,000	final report made.
Run Swamp Drainage District	Camden and Currituck	18,000	petitioned for.
Bear Swamp Drainage District	Chowan	5,000	completed.
Chadbourn Drainage District	Columbus	7,300	completed. (cost $7,593.60).
Clay, Red Swamp and Swift Creek Drainage District	Craven		petitioned for.
Dover Drainage District	Craven	9,000	organized and dredges at work.
Moseley Creek Drainage District	Craven	10,000	organized and at work.
Flea Hill Drainage District	Cumberland	20,425	final report made (cost $78,492).
Suggs Creek Drainage District	Cumberland	3,000	petitioned for.
Moyock Drainage District No. 1	Currituck	14,000	final report made.
Maxwell, Elder and Stockinghead Creeks Drainage District	Duplin	2,500	petitioned for.
Muddy Creek Drainage District	Duplin	1,925	organized.
Deep Creek Drainage District No. 1	Edgecombe and Halifax	6,300	petitioned for.
Beaver Dam Drainage District	Harnett	7,500	final report made (cost $16,065).
Juniper Bay Drainage District	Hyde	7,000	completed.
Mattamuskeet Lake Drainage District No. 1	Hyde	115,000	completed.
Abandoned Rice Lands	New Hanover	414	petitioned for.
Angola Bay Drainage District	Pender	14,700	petitioned for.
Rocky Point Drainage District	Pender	7,000	petitioned for.
Parkhill Drainage District, No. 1	Perquimans		completed.
Deep Creek Drainage District	Pitt		fallen through.
Little Contentnea Creek Drainage District	Pitt	8,000	fallen through.
Back Swamp and Jacob Swamp Drainage District	Robeson	35,000	completed. (cost $142,621).
Hog Swamp Drainage District	Robeson	15,000	petitioned for.
Little Coharie Drainage District	Sampson	3,300	final report made.
Creswell Drainage District	Washington		not yet organized.
Lake Phelps Drainage District	Washington and Tyrrell	75,000	final report made.
Wayne County Drainage District, No. 1	Wayne	2,600	completed.

DRAINAGE DISTRICTS IN SWAMP AREAS—CONTINUED.

NAME OF DISTRICT	COUNTY	NO. OF ACRES	PROGRESS OF DISTRICT
Toisnot Drainage District	Wilson	2,200	organized and at work.
Wilson County Drainage District, No. 2	Wilson		petitioned for.
Big Coharie Drainage District	Sampson		petitioned for.
Big Long Creek and Tributaries			petitioned for.

The North Carolina Drainage Law is just as applicable to the drainage of overflowed land in the Piedmont section of the State, and the following twenty districts have been organized or are in the process of organization:

DRAINAGE DISTRICTS IN OVERFLOWED LANDS.

NAME OF DISTRICT	COUNTY	NO. OF ACRES	PROGRESS OF DISTRICT
Brown Creek Drainage District	Anson	7,500	not yet organized.
Silver Creek Drainage District	Burke	1,400	petitioned for.
Lower Creek Drainage District	Caldwell and Burke	3,000	completed.
Buffalo Creek Drainage District	Cleveland	1,800	final report made.
Middle Fork of Muddy Creek Drainage District	Forsyth	550	completed.
Muddy Creek and Mill Creek Drainage District	Forsyth		completed.
Crowder's Creek Drainage District	Gaston	1,200	completed.
Dutchman's Creek Drainage District	Gaston	1,000	completed.
Long Creek Drainage District	Gaston	1,200	completed.
Horsepen Creek Drainage District	Guilford		petitioned for.
Reedy Fork and Haw River Drainage District	Guilford and Rockingham	176,000	petitioned for.
Falls—Byers Creek Drainage District	Iredell		petitioned for.
Fourth Creek Drainage District	Iredell		completed.
Third Creek Drainage District	Iredell	48,000	completed.
Indian Creek Drainage District	Lincoln		organized.
Clark's Creek Drainage District	Lincoln and Catawba	2,400	completed.
Potts Creek Drainage District	Lincoln and Catawba		petitioned for.
McLendon's Creek Drainage District	Moore	1,500	petitioned for.
Mecklenburg Drainage District	Mecklenburg		completed.
Haw River Drainage District	Rockingham		petitioned for.
Third Creek Drainage District	Rowan		petitioned for.

The State Survey has had the hearty coöperation of the Office of Drainage Investigations of the United States Department of Agriculture, and that office has carried on many investigations in the State during the past two years. This work has consisted principally in the examination of various swamp and overflowed areas, as to their being practical projects.

The preliminary examinations have been made on the following swamp areas by Mr. C. W. Mengel, engineer, on the dates indicated:

Project.	*County.*	*Date Examined.*
Beaver Dam Swamp	Harnett	June 14-15, 1911
Brown Marsh	Bladen and Columbus	June 8-9, 1911
Carver's Creek Drainage Dist.	Cumberland	Sept. 16-17, 1912
Flea Hill Drainage Dist.	Cumberland	May 17-19, 1911
Gapway Swamp	Columbus and Horry (S. C.)	Oct. 10-11, 1911
Maxwell Creek	Duplin	July 20-21, 1911
Richland Township	Beaufort	Aug. 10-14, 1911
Upper Little River	Harnett	Apr. 11, 1912
OVERFLOWED AREAS.		
Buffalo Creek	Cleveland	Oct. 18-19, 1911
Dutchman's Creek	Gaston	Feb. 26, 1912
Little Sugar Creek	Mecklenburg	May 24-25, 1911

Examinations of all these projects were made by Mr. C. W. Mengel, with the exception of the Buffalo Creek Drainage District, which was made by Mr. F. G. Eason.

In addition to these preliminary examinations, surveys were made of the following projects on the dates indicated opposite each:

Project.	*County.*	*Date Examined.*
Agr. and Mech. College	Guilford	Apr., May, 1912
Beaver Dam Swamp	Harnett	September, 1911
Buffalo Creek Drainage Dist.	Cleveland	January, 1912
Flea Hill Drainage Dist.	Cumberland	October, 1911
Little Sugar Creek	Mecklenburg	September, 1911
Pender Test Farm	Pender	July, 1912

These surveys were all made by Mr. C. W. Mengel, with the exception of the Buffalo Creek Drainage District, which was made by Mr. F. G. Eason.

The survey made of the farm at the Agricultural and Mechanical College at Greensboro was for the purpose of devising a plan for the installation of an underdrainage system of about one hundred and seven acres of this farm. The reports and plans prepared as a result of the survey made of the Pender Test Farm are supplemental to the report previously prepared on this same project by Mr. J. R. Haswell, and provides for the installation of additional tile. The reports relating to the above mentioned surveys were prepared for the purpose of providing adequate drainage for the respective drainage systems.

In addition to the above enumerated reports, a report was prepared in February, 1912, by Mr. S. W. Frescoln, Drainage Engineer of the Office of Drainage Investigations, on the Dimensions and Slopes of

Ditches, shown on a plan submitted by the Board of Commissioners of Mattamuskeet Drainage District No. 1 in Hyde County.

The Office of Drainage Investigations has also assisted the drainage work in the State by addresses by several of its engineers.

On November 10, 1911, Mr. C. G. Elliott, who was then Chief of that Office, made an address on "Drainage in Robeson County," at Lumberton. On November 15, 1911, Mr. Elliott made an address at the Fourth Annual Convention of the North Carolina Drainage Association, which was held at Elizabeth City, his subject being "Some Essential Features of Drainage in North Carolina."

On February 14, 1912, Mr. George M. Warren delivered an address on "Tile Drainage" before the students of the Agricultural and Mechanical College for the Colored Race, at Greensboro.

On November 26 and 27, 1912, Mr. C. W. Mengel attended the Fifth Annual Convention of the North Carolina Drainage Association and delivered an illustrated lecture on Drainage, particular reference being made to conditions in that State. On October 28, 1911, Mr. C. G. Elliott had an interview with the Governor and Secretary of State, during which the future needs of drainage in that State were discussed.

The State Survey has coöperated with the North Carolina Drainage Association in preparing for two Drainage Conventions held in 1911 and 1912. The fourth Annual Convention was held at Elizabeth City on November 15 and 16, 1911. Delegates from 19 counties were present at this Convention. The proceedings are published in Economic Paper No. 26.

The Fifth Annual State Drainage Convention was held at Raleigh on November 26 and 27, 1912. Forty-seven counties reported. The proceedings are published in Economic Paper No. 31.

The following legislation is recommended, which, it is believed, will make the North Carolina drainage law more effective.

Suggested Drainage Legislation.

The General Assembly of North Carolina do enact:

Section 1. That it shall be the duty of the Drainage Commissioners of any drainage or levy district, organized and incorporated by and under authority of chapter 442 of the Public Laws of 1909, to have prepared at once a map of the drainage district which shall have plotted thereon the boundaries of the district, together with the boundaries of the various tracts of land within the boundaries of the district, with the name of the owner properly marked on map, so that it will be possible to identify the ownership of any such tract of land; and that a certified copy of said map shall be deposited with the Clerk of the Court and the Sheriff of the county or counties in which the drainage district is located.

Sec. 2. Any and every person owning land in any drainage district, organized and incorporated by and under authority of chapter 442 of the Public

Laws of 1909, at the time of its incorporation or any time thereafter while the district remains under the control of the incorporated Board of Drainage Commissioners, upon selling all or any part of his holdings in said district, shall have prepared and forwarded to the Clerk of the Court and the Sheriff a certified copy of a plot showing accurately what part of said parcel or tract of land has been sold, together with the name of the purchaser of said tract. Anyone failing to comply with this section shall be liable for the special drainage tax on said land; and this tax shall be collected by the Sheriff from the owner whose name is last indicated on the certified copy of the map of the district in the Clerk of the Court's office.

The Clerk of the Court and the Sheriff shall, on receipt of the certified copy of the plot of the tract of land sold, have this plotted and incorporated as part of the map previously furnished him by the Board of Drainage Commissioners.

SEC. 3. That section 14 of chapter 67 of the Public Laws of 1911 be amended by adding thereto the following:

Provided, further, that if the drainage district is established and the Board of Drainage Commissioners of said drainage district shall not refund to the State Treasury to the credit of the Department of Agriculture said sum or sums that have been loaned to the district as the first payment out of the funds received from the sale of the bonds of the district, each and all three of the Commissioners of the Board of Drainage Commissioners shall be guilty of a misdemeanor and subject to a fine and imprisonment; and the State Treasurer is herewith authorized and instructed to bring suit against said district for the amount of the loan and interest thereon: *Provided, further,* that if the drainage district is not established and the said sum or sums loaned to the district are not refunded to the State Treasury to the credit of the Department of Agriculture by the petitioners for the drainage district within sixty days after the Court has decided against the organization of the district, the State Treasurer is hereby authorized and instructed to bring suit against said petitioners for said loans, and against the sureties on their bond.

SEC. 4. That the State Treasurer is herewith authorized to receive North Carolina drainage bonds as deposits from banks, insurance companies and other corporations required by law to make deposits with the State Treasurer: *Provided,* that the Attorney-General shall have approved the form of bond before said bond is issued by the commissioners of any drainage district.

SEC. 5. That it shall be lawful for executors, administrators, guardians, fiduciaries generally to invest in said bonds.

SEC. 6. That the members of the Board of Drainage Commissioners of any drainage district, organized by and under authority of chapter 442 of the Public Laws of 1909, shall be allowed four dollars per diem and traveling expenses incurred in carrying out their duties as said commissioners, which shall be a legitimate charge against the district, and shall be paid by the Treasurer of the district out of any funds to the credit of said district: *Provided,* the commissioners shall be paid not to exceed fifteen days in any one year during the expenditure of the bond issue in the construction of the canals and ditches of the district. After that time they shall be paid not to exceed three days in any one year.

SEC. 7. That section 20 of chapter 442 of the Public Laws of 1909 is herewith amended by adding thereto the following: "That the Superintendent of Construction shall be allowed such salary and expenses as shall be determined by the Board of Drainage Commissioners."

SEC. 8. That, in order to assist the people of the State in the organization of drainage districts in the swamp and overflowed areas of the State, and to make preliminary surveys regarding the feasibility and practicability of the drainage of said areas, there is appropriated annually out of any moneys in the State Treasury, not otherwise appropriated, the sum of three thousand dollars for the purpose of carrying out the provisions of this section, the same to be drawn upon as directed by the Geological Board, upon warrant of the State Auditor.

MAGNETIC SURVEY

There have been established at every county seat in North Carolina, stations which mark the true north and south lines. These stations are marked with solid granite posts weighing about four hundred pounds each. The top of the monument is dressed about six inches square and is lettered

N. C. G. S.
and
U. S. C. S.

During the past two years the following work has been done by the United States Coast and Geodetic Survey on application of the State Geologist in regard to establishing new meridian lines and reoccupying the old stations. The results of this work are given below.

A new meridian line was established at Lumberton, N. C., in November, 1911, by W. M. Hill, of the Coast and Geodetic Survey. The north stone is in the northeast corner of the grounds surrounding the graded school, 158.6 feet from the northwest corner of the school building and 81.6 feet from the northeast corner of the fence surrounding Dr. Allen's house. It is lettered N. C. G. S. and U. S. C. S.,1899, and projects about 7 inches above ground. The south stone is about 117 feet distant. Magnetic observations were made over the north stone on November 26, 1911, the declination being two degrees and no minutes west.

Magnetic observations were also made at the old magnetic station in the courthouse grounds, the declination being one degree and twenty-two minutes west. The declination at this place in November, 1899, was one degree and twelve minutes west, showing an increase of ten minutes in the interval. The immediate surroundings have been changed so much by the erection of the new courthouse, that this quantity is probably not a true measure of the change of declination in that part of North Carolina, observations at other places indicating that it is nearer three minutes a year than one.

RUTHERFORDTON, N. C.

Date of observation	March 7, 1911.	
Latitude	35°	21′
Longitude	81	58
Magnetic declination	0	43.4 W.

A new meridian line 141 feet long was established in the grounds of the courthouse. It is marked by granite posts six inches square, projecting about twelve inches above ground and lettered N. C. G. S., U. S. C. S., 1899. The magnetic observations were made over the north stone, which is 23.5 feet from the north boundary of the grounds, 46.5 feet from the west boundary and about 198 feet from the northwest corner of the courthouse.

The following true bearings were determined:

Spire of Zion colored Methodist church	82°	29.4′	W. of S.
Presbyterian church steeple	9	16.0	E. of N.
White Methodist church steeple	61	48.9	E. of N.
Upper eastern corner of Rutherford Hospital	43	30.3	W. of S.

LAURINBURG, N. C.

Date of observation	March 25, 1911.	
Latitude	34°	46′
Longitude	79	28
Magnetic declination	1	41.8 W.

A new meridian line about 195 feet long was established in the grounds of the graded school. It is marked by granite posts 6 inches square, lettered N. C. G. S., U. S. C. S.

The magnetic observations were made over the south stone, which is 43 feet from the south border of the grounds, 161 feet from the east border and 169 feet from the stake at the southeast corner.

The following true bearings were determined:

Rod on cupola of James Sanitarium	26°	50.3′	W. of N.
Top of town water tank	26	28.3	W. of N.
Lower southeast corner of jail cupola	6	41.2	W. of N.
Top of factory smokestack	67	15.4	E. of N.
Top of factory smokestack	77	23.0	E. of N.

WHITEVILLE, N. C.

Date of observation	March 29, 1911.	
Latitude	34°	21′
Longitude	78	42
Magnetic declination	2	02.6 W.

Magnetic observations were made over the north stone of the meridian line established in 1899, in the northwest corner of the courthouse grounds. The south stone was moved 23 feet to the north.

The following true bearings were determined:

Lower west edge of Baptist church steeple......	2° 18.3′ E. of S.

SANFORD, N. C.

Date of observation	April 4, 1911.
Latitude	35° 28′
Longitude	79 10
Magnetic declination	2 19.4 W.

A meridian line about 420 feet long was established in the courthouse grounds. It is marked by brownstone posts 6 by 8 by 36 inches, projecting about 7 inches above ground. The south stone has a brass station marker set in the top and the north stone has a small drill hole to mark the exact line. Magnetic observations were made over the south stone, which is near the south corner of the grounds, 10 paces from the southwest border of the grounds and 48 paces from the southeast border.

The following true bearings were determined:

Lower southwest corner of brick frieze around roof of jail....................................	29° 49.1′ W. of N.
North gable of roof of McPhail's house...........	64 11.5 W. of N.
Lower west edge of west chimney of the Ryan homestead	32 55.2 W. of S.

RAEFORD, N. C.

Date of observation..................................	April 11, 1911.
Latitude	35° 00′
Longitude	79 13
Magnetic declination	1 25.6 W.

A meridian line about 240 feet long was established in a grove of pine trees belonging to State Senator McLauchlin, just east of the property reserved for the county courthouse and jail. It is marked by two brownstone posts 6 by 8 by 42 inches, projecting about 9 inches above the ground. The south stone has a brass station marker set in the top, and in the north stone is a small drill hole. Magnetic observations were made over the south stone.

Upper northeast corner of Raeford Drug Co......	50° 43.2′ W. of S.
Lower southwest corner of main building of graded school	84 50.7 W. of N.
East gable of small wooden church................	51 06.6 W. of N.

BAKERSVILLE, N. C.

Date of observation	April 22, 1911.
Latitude	36° 01′
Longitude	82 02
Magnetic declination	1 27.7 W.

A new meridian line 212 feet long was established in the grounds of the Bowman Academy. It is marked by granite posts 7 inches square, projecting about 12 inches above ground, and lettered N. C. G. S., U. S. C. S., 1900. Magnetic observations were made over the north stone, which is 28 feet from the north fence and 55.7 feet west of the northwest corner of the Academy building.

The following true bearings were determined:

West gable of storehouse on Charles Stewart's property	16° 32.0′ E. of S.
East gable of Dr. V. R. Butts' house	74 33.9 W. of N.

The following table shows the results of magnetic observations made in North Carolina by the United States Coast and Geodetic Survey between December 1, 1910, and November 30, 1912.

RESULTS OF MAGNETIC OBSERVATIONS MADE IN NORTH CAROLINA BY THE UNITED STATES COAST AND GEODETIC SURVEY BETWEEN DECEMBER 1, 1910, AND NOVEMBER 30, 1912.

Station	Lat.	Long.	Date	Decl'n.	Dip	Hor. Int.	Observer
	° ′	° ′	1911	West ° ′	° ′	7	
Rutherfordton, new	35 21	81 58	Mar. 7, 8	0 42.6	67 09.5	22622	W. M. Hill
Laurinburg, old	34 46	79 28	Mar. 24	1 34.9	66 46.5	22657	do
Laurinburg, new	34 46	79 28	Mar. 25	1 41.0	66 47.6	22629	do
Whiteville, old	34 21	78 42	Mar. 28, 29	2 01.8	66 13.0	23078	do
Sanford	35 28	79 10	Apr. 3, 6	2 18.6	67 41.8	22065	do
Raeford	35 00	79 13	Apr. 11	1 24.8	67 23.5	22410	do
Bakersville, old	36 02	82 11	Apr. 20, 21	2 13.2	67 31.3	22483	do
Bakersville, new	36 01	82 09	Apr. 21, 22	1 26.9	67 46.4	22298	do
Lumberton, old	34 37	79 01	Nov. 23, 24	1 22.2	66 10.4	23244	do
Lumberton, new	34 37	79 01	Nov. 25, 26	2 00.1	66 38.1	22754	do
			1912				
Gatesville, old	36 24	76 43	May 10, 11	4 29.6	68 20.7	21560	F. Neuman
Gatesville, new	36 24	76 42	May 10, 11	4 29.6	68 27.2	21471	do
Salisbury, old	35 40	80 30	May 14	0 57.8	67 33.7	22029	do
Marshall, old	35 47	82 41	May 20	0 27.4	66 49.7	23262	do
Marshall, new	35 47	82 40	May 21	0 04.4	67 34.4	22386	do
Newland	36 05	81 56	May 24, 25	0 37.4	68 05.0	21879	do

COMPARISON OF DECLINATION RESULTS AT REPEAT STATIONS

Station	Former Observation		Last Observation		Average Annual Change
	Date	Decl'n.	Date	Decl'n.	
		West ° '		West ° '	
Rutherfordton (c)	1899 Aug.	0 15.6	1911 Mar.	0 42.6	2.3
Laurinburg	1899 Nov.	1 20.6	1911 Mar.	1 34.9	1.3
Whiteville	1899 Nov.	1 43.8	1911 Mar.	2 01.8	1.6
Bakersville (c)	1900 Sept.	0 40.8	1911 Apr.	1 26.9	4.3
Lumberton (c)	1899 Nov.	1 12.0	1911 Nov.	2 00.1	4.0
Gatesville	1899 Apr.	3 45.2	1912 May	4 29.6	3.4
Salisbury	1905 Apr.	0 33.4	1912 May	0 57.8	3.4
Marshall	1906 Aug.	0 16.4	1912 May	0 27.4	1.9

(c) At these stations the former and last observations were made at different places.

FISHING INDUSTRIES

In the act creating the North Carolina Geological and Economic Survey, passed by the General Assembly of 1905, one of the objects of the survey was an examination of the fishing resources of the State. The investigation of the fisheries of the State was begun in 1905, and has been continued almost constantly since that time. The fisheries of the State come under the head of the natural resources, and therefore, their investigation comes under the general head of conservation.

In considering the subject of conservation one is not apt to take into account that it does apply in a very real and practical way to the protection and perpetuation of our fish, oysters, and other products of the sea, as much as to the protection and perpetuation of the natural resources of the land. There is no doubt but that the supply of edible fish, clams, oysters, and other sea products in the waters of North Carolina is becoming less and less each year. There are two reasons for this condition: (1) Insufficient laws for the protection and regulation of the catch of fish and oysters; and (2) nonenforcement of the laws which have already been passed. In some counties of the State the laws we now have on our statute books are practically dead letters for the reason that there is no way of enforcing them.

The falling off in the catch of edible fish is not due to the use of any particular apparatus, but to over fishing and the use of fishing apparatus in places where it ought not to be used. Hundreds of thousands of small fish have been caught, which, if allowed to remain in the water, would in a year or two become valuable edible fish. The small fish caught in this way are often dumped on the shore and used as fertilizer or shipped to market with a faint hope that they may be marketable, but in most cases they are thrown out by the dealer as unsalable. If the small fish are destroyed (by whatever means) it is a self-evident fact that it will not be long before there will be a scarcity of big ones; and finally certain fish will become extinct in North Carolina waters.

It is possible to protect and perpetuate our fish and oyster industries by the enactment and enforcement of adequate laws. I believe that the only adequate method of enforcing State laws and fostering our fishing industries is through the operation of a State Fish Commission having jurisdiction over all the commercial fisheries in all the counties of the State. The work of such a commission should be not only to see that the laws are enforced, but it should be able to carry on investigations relating to the fishing industries; to study local conditions and be able to render just decisions in regard to the best policy to pursue for the perpetuation of the oyster and any other type of fish with the idea of subserving the best interests of the State. Up to the present time the fisheries have been considered as merely local matters, while as a matter of fact they do not belong to any county or section, but to the State as a whole, and the best results can only be obtained when the fisheries are thus considered.

We, North Carolinians, are too apt to merely consider and be interested in local conditions—those which affect our own county, township, or town, and not to realize that we are citizens of a State, and that whatever operates to the detriment of any portion of the State affects every other portion either directly or indirectly. The great difference in the topography of our State and in the industries resulting from such varied conditions has a tendency to sectionalize, so to speak, the western, middle, and eastern portions of the State, and it is rather hard to enlist the sympathies of the mountain folk in what affects the welfare of the man on the coast. If we are, however, to build up a great progressive State, one which is to reap in the fullest measure the value of the abundant wealth with which nature has endowed it, the citizens of the mountains must consider the natural resources of the coast, and the man on the coast must have regard for the conservation of our mountain resources. We are mutually dependent and citizens of a State, and we want our legislators to realize this and be statesmen enough to consider the welfare of the State before that of any particular section.

The report of the legislative committee appointed by the General Assembly of 1909, which was made in the form of a bill which was introduced in the General Assembly of 1911, passed the House, but was defeated in the Senate. The substance of this bill was the creation of a fisheries commission, which should have jurisdiction over all the commercial fisheries of the State. The full report of the work of this committee is given in Economic Paper No. 29 of the publications of the Geological and Economic Survey. One result of the defeat of this bill was the organization of the North Carolina Fisheries Association, which was organized at New Bern on Wednesday, December 13, 1911, at a convention which was called by the Fish Commission, the Shellfish Commission, and the North Carolina Geological and Economic Survey. Delegates were in attendance at this convention from the following counties: Beaufort, Brunswick, Camden, Carteret, Chowan, Craven, Dare, Edgecombe, Granville, Hertford, Hyde, Jones, New Hanover, Onslow, Orange, Pamlico, Pasquotank, Perquimans, and Washington.

It is believed that these delegates thoroughly represented the various fishing interests in their counties. One of the resolutions passed by this convention was:

> "That the convention recommend the enactment by the General Assembly of a State-wide law regulating the preservation and taking of fin fish and shell fish in and from the waters of the State, and providing that such law shall be executed by a fisheries commission appointed by the General Assembly or otherwise, as may be provided; said commission to be vested with power to promulgate rules and regulations that shall have the force and effect of laws and shall have the power to fix the penalty for the violation thereof, and that said law be formulated by the Legislative Committee to be appointed at this meeting and to report at the next annual meeting of this association."

The Legislative Committee appointed by the Association was as follows: Messrs. George N. Ives of New Bern; C. Ed. Taylor of Brunswick; Charles S. Wallace, of Carteret; Joe F. Tayloe, of Beaufort; Frank Wood, of Chowan; A. S. Rascoe, of Bertie; Thomas J. Markham, of Pasquotank; Theodore S. Meekins, of Dare; R. A. Nunn, of Craven; Joseph Hyde Pratt, of Orange.

This committee, through correspondence and at a called meeting held in New Bern October 16, 1912, drafted a bill providing for general fish legislation, which was in substance the recommendations of the Legislative Committee of the General Assembly of 1909. There were present at the meeting: Messrs. Ives, Nunn, Taylor, Wood, Markham, and Pratt. Messrs. Meekins and Tayloe voted in favor of the recommendations adopted. These were presented to the Association at its annual convention held at Washington, N. C., December 4, 1912, and with a few minor changes were unanimously adopted.

SUGGESTED FISHERIES LEGISLATION.

The legislation recommended by the Fisheries Association is given below:

A BILL TO BE ENTITLED AN ACT TO ESTABLISH A FISHERIES COMMISSION AND TO PROTECT THE FISHERIES OF NORTH CAROLINA.

The General Assembly of North Carolina do enact:

SECTION 1. That for the purpose of enforcing the laws relating to all commercial fish there is hereby created a Fisheries Commission, which shall consist of the State Geologist and four members appointed by the Governor, upon recommendation of the North Carolina Fisheries Association, from the several fishing districts of the State, who, together with the State Geologist, shall be denominated the "Fisheries Commission Board." The members shall be appointed as follows, viz.: two, whose terms of office shall expire on the first day of June, one thousand nine hundred and thirteen, and two whose terms of office shall expire on the first day of June, one thousand nine hundred and fifteen; and their successors shall be appointed by the Governor for a term of four years each thereafter. The four members shall receive four dollars per day each and traveling expenses while attending meetings of the board: *Provided*, that the per diem and expenses shall not exceed two hundred and fifty dollars each per annum.

That said board shall appoint a Fish Commissioner within thirty days after the passage of this act, and the said commissioner shall be responsible to the Fisheries Commission Board for carrying out the duties of his office, and shall make semi-annual reports to them at such time as they may require. The term of office of said commissioner and his successors in office shall be four years, or until their successors are appointed and qualified, and in case of vacancy in the office the appointment shall be to fill the vacancy. The said commissioner shall appoint two assistant commissioners, by and with the consent of the Fisheries Commission Board, one of whom shall be designated as Assistant Fish Commissioner and the other as Shellfish Commissioner. The aforesaid commissioner and assistant commissioners shall receive such pay as the Fisheries Commission Board shall determine. During the absence of the commissioner, or his inability to act, the Fisheries Commission Board shall appoint one of the assistant commissioners to have and exercise all the powers of the commissioner. The commissioner and assistant commissioners shall each execute and file with the Secretary of State a bond, payable to the State of North Carolina, in the sum of five thousand dollars for the commissioner and twenty-five hundred dollars for each of the assistant commissioners, with sureties to be approved by the Secretary of State, conditioned for the faithful performance of their duties and to account for and pay over pursuant to law all moneys received by them in their office. The Fisheries Commissioner and assistant commissioners shall take and subscribe an oath to support the Constitution and for the faithful performance of the duties of his office, which oaths shall be filed with their bonds. The assistant commissioners may be removed for cause by the commissioner, who may appoint their successors.

SEC. 2. *Inspectors.*—The Fisheries Commissioner may appoint, with the approval of the Fisheries Commission Board, inspectors in each county having fisheries under his jurisdiction, who will assist him at such times as he may require. The said inspector shall serve under the direction of the commissioner, receiving compensation not to exceed three dollars per day and necessary expenses while in actual service.

SEC. 3. *Office and Clerical Force.*—The Fisheries Commissioner shall rent and equip an office, which will be adequate for the business of the commission, in some town conveniently located to the maritime fisheries, and he is authorized to employ such clerks and other employees as may be necessary for the proper carrying on of the work of his office, by and with the consent of the Fisheries Commission Board.

Sec. 4. *Equipment.*—The Fisheries Commissioner is authorized, by and with the consent of the Fisheries Commission Board, to purchase or rent such boats, nets, and other equipment as may be necessary to enable him and his assistants to fulfill the duties specified in this act.

Sec. 5. *Duties.*—The commissioner shall enforce all acts relating to the fish and fisheries of North Carolina; he shall, by and with the advice and consent of the Fisheries Commission Board, make such regulations as shall maintain open for the passage of fishes all inlets and not less than one-third of the width of all sounds and streams, or such greater proportions of their width as may be necessary; he shall collect and compile statistics showing the annual product of the fisheries of the State, the capital invested and the apparatus employed, and any fisherman refusing to give these statistics shall be refused a license for the next year; and the Fish Commissioner shall prepare and have on file in his office maps based on the charts of the United States Coast and Geodetic Survey, of the largest scale published, showing as closely as may be the location of all fixed apparatus employed during each fishing season; he shall have surveyed and marked in a prominent manner those areas of waters of the State in which the use of any or all fishing appliances are prohibited by law or regulation, and those areas of waters in the State in which oyster tonging or dredging is prohibited by law; he shall prosecute all violations of the fish laws, and whenever necessary he may employ counsel for this purpose; wherever he shall find nets or other appliances being fished or used in violation of the fisheries laws of the State he shall remove same pending trial; he shall, in an official capacity, have power to administer oaths and to send for and examine persons and papers; he shall be responsible for the collection of all license fees, taxes, rentals, or other imposts on the fisheries, and shall pay same into the State Treasury to the credit of the Fisheries Commission fund; he shall, on or before the twenty-fifth day of each month, mail to the Treasurer of the State a consolidated statement showing the amount of taxes and license fees collected during the preceding month, and by and from whom collected; he shall carry on investigations relating to the migration and habits of the fish in the waters of the State, also investigations relating to the cultivation of the oyster, clam, and other mollusca, and of the terrapin, lobster, and crab, and for this purpose he may employ such scientific assistance as may be authorized by the Fisheries Commission Board.

Sec. 6. *Arrests Without Warrant; When and How Made.*—The Fisheries Commissioner, assistant commissioners and inspectors shall have power, with or without warrants, to arrest any person or persons violating any of the fishery laws, who shall be carried before a magistrate for trial according to section three thousand one hundred and eighty-two of The Revisal of one thousand nine hundred and five.

Sec. 7. *Power to Take Fish.*—The Fisheries Commissioner and the United States Bureau of Fisheries may take and cause to be taken for scientific purposes, or for fish culture, any fish or other marine organism at any time from the waters of North Carolina, any law to the contrary notwithstanding; and may cause or permit to be sold such fishes or parts of fishes so taken as may not be necessary for purposes of scientific investigations or fish culture:

Provided, that in taking fish for fish culture in the hatcheries of this State the fish shall only be taken while the hatcheries are in operation and only between the hours of 4 and 11 p. m.

SEC. 8. *No Interest in Fisheries.*—The members of the Fisheries Commission Board, the Fisheries Commissioner, assistant commissioners, and inspectors shall not be financially interested in any fishing industry in North Carolina.

SEC. 9. *Revenue.*—All license fees, taxes, rentals of bottoms for oyster or clam cultivation and other imposts upon the fisheries, in whatever manner collected, shall, except as otherwise provided in this act, be deposited with the State Treasurer to the credit of the Fisheries Commission fund, to be drawn upon as directed by the Fisheries Commission Board.

SEC. 10. *License to Fish and to Catch Oysters.*—Each and every person, firm, or corporation, before commencing or engaging in any kind of fishing in the State, shall file with an inspector of the county in which he desires to fish, or with the Fisheries Commissioner or one of his assistant commissioners, a sworn statement as to the number and kind of nets, seines, or other apparatus intended to be used in fishing. Upon filing this sworn statement on oath the Fisheries Commissioner shall issue or cause to be issued to the said party or parties a license as prescribed by law; said applicant shall pay a license fee equal in amount to the fee or tax prescribed by law for fishing different kinds of apparatus in the waters of the State of North Carolina, or for tonging or dredging for oysters, as the case may be. The Fisheries Commissioner shall keep in a book especially prepared for the purpose an exact record of all licenses, to whom issued, the number and kinds of nets, boats, and other apparatus licensed, and the license fees received. He shall furnish to each person, firm, or corporation in whose favor a license is issued a special tag which will show the license number and number of pound nets, or yards of seine, or yards of gill net that the licensee is authorized to use, and the licensee shall attach said tag to the net in a conspicuous manner satisfactory to the Fisheries Commissioner. All boats or vessels licensed to scoop, scrape, or dredge oysters shall display on the port side of the jib, above the reef and bonnet and on the opposite side of mainsail, above all reef points, in black letters, not less than twenty inches long, the initial letter of the county granting the license and the number of said license, the number to be painted on canvas and furnished by the Fisheries Commissioner, for which he shall receive the sum of fifty cents. Any boat or vessel used in catching oysters without having complied with the provisions of this section may be seized, forfeited, advertised for twenty days at the courthouse and two other public places in the county where seized, and sold at some public place designated in the advertisement, and the proceeds, less the cost of the proceedings, shall be paid into the school fund. The licenses to fish with nets shall all terminate on December thirty-first. Any person who shall willfully use for commercial fishing purposes any kind of net whatever, without having first complied with the provisions of this section, shall be guilty of a misdemeanor and, upon conviction, shall be fined twenty-five dollars for each and every offense.

SEC. 11. *License for Boat Used in Catching Oysters.*—The Fisheries Commissioner, or Shellfish Commissioner, or inspector, may grant license for a boat to be used in catching oysters upon application made, according to law, and the payment of a license tax as follows: On any boat or vessel without cabin or deck, and under custom house tonnage, using scoops, scrapes, or dredges, measuring over all twenty-five feet and under thirty, a tax of three dollars; fifteen feet and under twenty-five feet, a tax of two dollars; on any boat or vessel with cabin or deck and under custom house tonnage, using scrapes or dredges, measuring over all thirty feet or under, a tax of five dollars; over thirty feet a tax of six dollars; on any boat or vessel using scoops, scrapes, or dredges required to be registered or enrolled in the custom house, a tax of one dollar and fifty cents a ton on gross tonnage. No vessel propelled by steam, gas, or electricity, and no boat or vessel not the property absolutely of a citizen or citizens of this State, shall receive license or be permitted in any manner to engage in the catching of oysters anywhere in the waters of this State.

SEC. 12. *Fishing for Menhaden With Purse Nets.*—Whenever any person or persons, corporation or corporations, may intend to take menhaden (fatbacks), porgies, herring, or other fish in any waters within the jurisdiction of this State, including the waters of the Atlantic Ocean within three nautical miles of the coasts of said State, either on his own account and benefit or on account and benefit of his employer, with purse or shirred nets, such person or persons, corporation or corporations, shall make an application to the Fisheries Commissioner for a license, and, upon the receipt of such application, the Fisheries Commissioner shall, upon the receipt of a sum equal to two dollars for each ton of the net tonnage of each vessel employed in such fishing, said net tonnage to be determined by custom house measurement, as a license fee, issue to such person or persons, corporation or corporations, a license duly signed by the Fisheries Commissioner, which said license shall be valid and in force for the term of one year; all such licenses to be dated from January first, and no license shall be for a space of time less than one year. For every violation of this act the offending person or persons, corporation or corporations, shall be guilty of a misdemeanor and be fined two hundred dollars for each and every offense.

SEC. 13. *Purchase Tax.*—All dealers in oysters and all persons who purchase oysters for canning, packing, shucking, or shipping, shall pay a tax of two cents on every bushel of oysters purchased by them, or caught by them, or by any one for them: *Provided*, that no oyster shall be twice taxed. This tax shall be paid to and collected by the inspectors, and, when paid, a receipt shall be given therefor. Upon failure or refusal by any person, firm, or corporation to pay said tax, his license as a dealer shall at once become null and void, and no further license shall be granted him during the current year; and it shall be the duty of the commissioner, assistant commissioner, or inspector to institute suit for the collection of said tax. Such suit shall be in the name of the State of North Carolina on relation of the commissioner or of the inspector at whose instance such suit is instituted, and the recovery shall be for the benefit and to the use of the general Fisheries Commission fund.

SEC. 14. *License Tax.*—The following license tax is hereby levied annually upon the different fishing appliances used in the waters of North Carolina:

Anchor gill nets, twenty cents per one hundred yards or fraction thereof.

Stake gill nets. ten cents per one hundred yards or fraction thereof.

Drift gill nets, twenty cents per one hundred yards or fraction thereof.

Pound nets, one dollar each.

Seine, drag nets, and mullet nets under one hundred yards, one dollar each.

Seine, drag nets, and mullet nets over one hundred yards and under three hundred yards, one dollar per one hundred yards or fraction thereof.

Seine, drag nets, and mullet nets over three hundred yards and under one thousand yards, one dollar and twenty-five cents per one hundred yards or fraction thereof.

Seine, drag nets, and mullet nets over one thousand yards, one dollar and seventy-five cents per one hundred yards or fraction thereof.

Fyke nets, twenty-five cents each.

Tonging for oysters, the license tax shall be one dollar for each tonger.

SEC. 15. *Reports.*—The Fisheries Commission Board shall cause to be prepared and submitted to each Legislature a report showing the operations, collections and expenditures of the Fisheries Commission; it shall also cause to be prepared for publication such other reports, with necessary illustrations and maps, as will adequately set forth the results of the work and the investigations of the Fisheries Commission, all such reports, illustrations, and maps to be printed and distributed at the expense of the State, as are other public documents, as the Fisheries Commission Board may direct.

SEC. 16. *Appropriation.*—There is hereby appropriated out of the General Treasury as a supplementary fund the sum of ten thousand dollars annually for four years, or as much thereof as may be needed, to the Fisheries Commission to carry out the work of the commission in the protection and promotion of the fisheries of the State, this sum to be repaid to the General Treasury by the Fisheries Commission when it shall be on a self-sustaining basis, said sum to be used and expended as directed by the Fisheries Commission Board, and any part of it that may be required may be used for purchasing boats and other equipment necessary to carry out the work of the commission; and any money that may be in the State Treasury to the credit of the Fish Commission and Oyster Commission fund on the day that this act becomes effective shall be transferred by the State Treasurer to the credit of the Fisheries Commission fund, and the Fisheries Commission Board is hereby authorized to pay out of the Fisheries Commission fund all just claims that may be outstanding against the Fish or Oyster Commissions.

SEC. 17. *Transfer of Equipment.*—All boats, fishing and oyster tackle, office supplies, stationery, and all other supplies of whatever character belonging to the Fish Commission and Oyster Commission shall be transferred to the Fisheries Commissioner for the use of the Fisheries Commission.

SEC. 18. *Jurisdiction of State.*—The State of North Carolina shall have exclusive jurisdiction and control over all the commercial fisheries of the State wherever located.

SEC. 19. It shall be unlawful to place in any of the waters of this State any dynamite, giant or electric powder, or any explosive substance whatever, or any drug or poisoned bait, for the purpose of taking, killing, or injuring fish. And any one violating this section shall, upon conviction, be fined not less than one hundred dollars and imprisoned not less than thirty days.

SEC. 20. It shall be unlawful to discharge or to cause or permit to be discharged into the waters of the State any deleterious or poisonous substance or substances inimical to the fishes inhabiting the said waters; and any person, persons or corporation violating the provisions of this section shall be guilty of a misdemeanor and, upon conviction, be fined or imprisoned in the discretion of the court.

SEC. 21. The Fisheries Commission Board is hereby authorized to regulate, prohibit, or restrict, in time, place, character, and dimensions, the use of nets, appliances, apparatus, or means employed in taking or killing fish; to regulate the seasons at which the various species of fish may be taken in the several waters of the State, and to prescribe the minimum sizes of fish which may be taken in the said several waters of the State; and such regulations, prohibitions, restrictions and prescriptions, after due publication, shall be of equal force and effect with the provisions of this act; and any person violating the provisions of this section shall be guilty of a misdemeanor, and upon conviction shall be fined or imprisoned at the discretion of the court: *Provided, however*, that if a petition signed by five or more voters of the district or community which will be affected by the proposed change is filed with the Fisheries Commission Board through the Fisheries Commissioner, assistant commissioners, or inspectors, asking that they have a hearing before any proposed change in the territory, size of mesh, length of net, or time of fishing shall go into effect, petitioning that they be heard regarding said change, the Fisheries Commission Board shall in that event designate by advertisement for a period of thirty days at the courthouse and three other public places in the county affected, and also by publication in a newspaper of the county, if such is published in said county, for two consecutive weeks, a place at which said board will meet and hear argument for and against said change, and may ratify, rescind, or alter this previous order of change as may seem just in the premises; and *Provided, further*, that in making regulations the Fisheries Commission Board shall give due weight and consideration to all factors which will affect the value of the present investment in the fisheries, and that no changes in the existing laws which, if they should go into effect immediately would tend to cause fishermen to lose their property, shall go into effect until twelve months from the date that the change has been made by the Fisheries Commission Board.

SEC. 22. Any person or persons removing, injuring, defacing, or in any way disturbing the posts, buoys, or any other appliances used by the Fisheries Commission in marking the restricted areas relating to any and all fishing, or marking other areas in which oyster tonging or dredging is prohibited by law, and those marking oyster bottoms that are leased for oyster cultivation, shall be guilty of a misdemeanor and, upon conviction, shall be fined or imprisoned at the discretion of the court; and any person anchoring or mooring a boat to any of these buoys or posts shall, upon conviction, be fined not less than twenty-five or more than one hundred dollars, and imprisoned thirty days in jail at the discretion of the court.

SEC. 23. Wherever the word fish or fishes used as a substantive occurs in this act it shall be construed to include porpoises and other marine mammals, fishes, mollusca, and crustaceans, and wherever the word fishing or fisheries occurs it shall be construed to include all operations involved in using, setting, or operating apparatus employed in killing or taking the said animals or in transporting and preparing them for market.

SEC. 24. That all acts relating to the commercial fisheries of North Carolina are hereby amended so that the words "Shellfish Commissioner," "Oyster Commissioner," or "Fish Commissioner" shall read "*Fisheries Commissioner*"; and the words "Shellfish Commission," "Oyster Commission," or "Fish Commission" shall read "*Fisheries Commission.*"

SEC. 25. All laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 26. That this act shall be in force from and after its ratification.

The following counties were represented at the meeting of the Legislative Committee, or at the convention, and their delegates took part in the discussion and adoption of the above legislation: Beaufort, Brunswick, Carteret, Chowan, Craven, Currituck, Dare, Edgecombe, Hyde, Orange, Pamlico, Pasquotank, Perquimans and Pitt.

This bill will be introduced in the General Assembly of 1913, and the Association and the Survey are united in urging its passage, believing that it is for the best interest of the fishing industry of the State.

The investigations of the Survey in regard to the cultivation of the oyster and the diamond back terrapin, which have been carried on in coöperation with the United States Bureau of Fisheries, have led to the opinion that both the oyster and the terrapin can be cultivated profitably in this State, provided the cultivator shall be protected in his rights regarding such cultivation. The legislation advocated above, if made into law, will cause the cultivation of the oyster, and also of the terrapin, to become industries of very great importance to the State. Then again the cultivation of the oyster will do more toward building up the oyster industry than any other cause.

The Survey and the Fish Commission have had the most cordial coöperation of the United States Bureau of Fisheries and the United States Coast and Geodetic Survey.

The latter Federal Bureau assisted us in the location of stakes and buoys used in marking restricted areas in Pamlico and Roanoke sounds. This work was done by Mr. J. C. Gauger, engineer, during the month of February, 1911.

Later in the year, from October 2d to December 16th, 1911, W. M. Steirnagel, of the Coast and Geodetic Survey, was in North Carolina revising the former work and re-locating and replacing stakes, etc., which had been destroyed or removed. This engineering work has been of very great value to the State and we can undoubtedly count on even more coöperative work of this character if the fisheries commission bill is passed.

A law has already been passed by Congress authorizing the coöperation of the United States Bureau of Fisheries and the Coast and Geodetic Survey with the North Carolina Fish Commission in locating restricted fishing areas, and if the fisheries commission bill is passed, so that the State has jurisdiction over all the commercial fisheries, the State will be able to have the assistance of these Federal Bureaus in carrying on its work.

STATE FAIRS

The State Geological Survey has made exhibits at the State Fairs of 1911 and 1912. The exhibits consisted of minerals, the production of which offered opportunity for investment; specimens of North Carolina lumber products, consisting of both hard and soft woods; and maps, photographs and reports illustrating the work of the Survey. In the preparation of these exhibits the State was assisted by the Cranberry Furnace Company, of Cranberry, N. C., who sent a splendid collection illustrating their iron ore and its products; the Carolina Mineral Company, of Penland, N. C., who exhibited crude and ground feldspar; the Blue Pearl Granite Company, who sent a polished carved marker of their "blue pearl" granite; the Carolina Building and Hardware Company, of Aulander, Bertie County, who made an exhibit of their brick; the Statesville Brick Company, of Statesville, N. C., who sent two of their brick; the Carolina Lime Company, of New Bern, N. C., who sent a sample of the shell rock known as "Coquina," which is used for fertilizing purposes. All of the material was donated to the State Survey for use in future exhibits and at the State Museum.

PUBLICATIONS

During the two years, 1911 and 1912, the following publications have been issued by the North Carolina Geological and Economic Survey, which embody the results of the investigations that have been outlined above and to which references have been made.

VOLUMES.

Volume III. The Coastal Plain Deposits of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs.

Pt. I. The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II. The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

BULLETINS.

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 115 pp.

ECONOMIC PAPERS.

21. Proceedings of the Third Annual Drainage Convention, compiled by Joseph Hyde Pratt, 1911. 67 pp.
22. Forest Fires in North Carolina During 1910, by J. S. Holmes, 1911. 48 pp.
23. Mining Industry in North Carolina During 1908-'09-'10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 134 pp.
24. The Fishing Industry in North Carolina, by Joseph Hyde Pratt, 1911. 44 pp.
25. Proceedings of the Forestry Convention, and Forest Fires in North Carolina During 1911, by J. S. Holmes, 1911. 71 pp.
26. Proceedings of Fourth Annual Drainage Convention, compiled by Joseph Hyde Pratt, 1912. 45 pp.
27. Highway Work in North Carolina, by Joseph Hyde Pratt and Miss H. M. Berry, 1912. 145 pp.

28. Culverts and Small Bridges for County Roads, by C. R. Thomas and T. F. Hickerson, 1912. 56 pp.

29. Report of Fisheries Convention of 1911, and Report of Proceedings of the Legislative Committee of the General Assembly of 1909, compiled by Joseph Hyde Pratt, 1912. 302 pp.

30. Proceedings of Annual Good Roads Convention of 1912, compiled by Joseph Hyde Pratt and Miss H. M. Berry, 1912. 109 pp.

GOOD ROADS CIRCULARS.

There have been published during the past two years the following Good Road Circulars. These have been written by the State Geologist, unless otherwise stated.

61. State Highway Commission, December 20, 1910. 12 pp.

62. Suggested Legislation for State Aid to Counties in Public Road Work, December 30, 1910. 9 pp.

63. Digest of Good Roads Legislation, January 20, 1911. 4 pp.

64. Press Comments Relative to the Good Roads Situation, February 14, 1911. 18 pp.

65. Public Road Work in North Carolina During 1910, March 30, 1911. 21 pp.

66. Dirt Roads, May 10, 1911. 4 pp.

67. Annual Good Roads Convention, May 20, 1911. 3 pp.

68. Good Public Roads, Their Beneficial Results and How to Obtain Them, June 6, 1911. 20 pp.

69. Program of North Carolina Good Roads Association, June 3, 1911. 3 pp.

70. Résumé of Work Done by the North Carolina Good Roads Association, July 1, 1911. 10 pp.

71. Methods of Financing Good Roads, by P. D. Gold, Jr., July 18, 1911.

72. County Good Roads Associations, July, 1911. 4 pp.

73. Dirt Roads, August 10, 1911. 10 pp.

74. Annual Convention of the Southern Appalachian Good Roads Association, August 21, 1911. 3 pp.

75. Meetings of Interest in North Carolina, September 1, 1911. 4 pp.

76. Program of Convention of Southern Appalachian Good Roads Association, September 15, 1911. 4 pp.

77. A Message to All Good Roads Advocates, February 23, 1912. 4 pp.

78. Why Orange County Should Have a Bond Issue, February 24, 1912.

79. Convention of Southern Appalachian Good Roads Association, March 1, 1912. 3 pp.

80. Program of Southern Appalachian Good Roads Association, March 20, 1912. 4 pp.

81. Suggestions to Road Officials Concerning Construction and Drainage of Public Roads, by R. T. Brown, April 16, 1912. 6 pp.

82. Construction of the Sand-clay Road, June 19, 1912. 5 pp.

83. Annual Convention of the North Carolina Good Roads Association, June 22, 1912. 4 pp.

84. Annual Convention of the North Carolina Good Roads Association, July 16, 1912. 3 pp.

85. Construction of the Sand-clay Road, July 18, 1912. 5 pp.

86. Program of Convention of North Carolina Good Roads Association, July 24, 1912. 4 pp.

87. Report of Convention of North Carolina Good Roads Association, August 9, 1912. 6 pp.

88. Fourth Annual Convention of the Southern Appalachian Good Roads Association, September 20, 1912. 2 pp.

89. Program Annual Convention of Southern Appalachian Good Roads Association, November 1, 1912. 4 pp.

90. County Road Law, January 1, 1913. 8 pp.

There has been a constant demand for publications relating to good roads, and the circulars referred to above are in constant demand, and it has been necessary in some cases to publish them in editions of from three to six thousand.

PRESS BULLETINS.

During the past two fiscal years Press Bulletins 43 to 93, inclusive, have been published and distributed by the North Carolina Geological and Economic Survey. These Press Bulletins have discussed various questions relating to Forestry, Drainage, Mining, etc., and have been issued in order to give to the people of the State a comprehensive idea of the work that the Survey is doing, and also in order to bring before the people at once certain information that the Survey has collected upon some particular subject. The Press Bulletins also call attention to the more detailed reports that the Survey is publishing as Bulletins and Economic Papers. The newspapers are quoting very freely from these Press Bulletins, and thus the information collected by the Survey is being given more general circulation.

The following is a list of the Press Bulletins published during the two past years:

43. Work of the North Carolina Geological and Economic Survey, December 3, 1910. 13 pp.

44. Let us Economize (by Preventing Forest Fires), December 10, 1910. 3 pp.

45. Tile Drainage, by J. R. Haswell, December 20, 1910. 11 pp.

46. Forest Fires and Suggestions Relative to Their Prevention, December 22, 1910. 8 pp.

47. Revenue for Forest Protection. December 31, 1910. 4 pp.

48. Forestry Convention, January 17, 1911. 3 pp.

49. Arbor Day in the North Carolina Schools, April 3, 1911. 3 pp.

50. Drainage Convention, October 1, 1911. 3 pp.

51. North Carolina Forestry Association, October 6, 1911. 3 pp.

52. Planning to Control the Pine Barkbeetle, October 12, 1911. 4 pp.

53. Program of Annual Drainage Convention, November 1, 1911. 4 pp.

54. Mineral Production of North Carolina During 1908, 1909, 1910, November 22, 1912. 2 pp.

55. Fisheries Convention, December 28, 1911. 2 pp.

56. What Shall We Do With Our Fisheries? February 1, 1912. 2 pp.

57. Planting Shade Trees, February 9, 1912. 4 pp.

58. Program of Forestry Convention, February 12, 1912. 4 pp.

59. Proceedings of Forestry Convention, March 8, 1912. (Circular.)

60. The Southern Pine Beetle and Its Control, by E. B. Mason, March 9, 1912. 4 pp.
61. The Stock Law and Forest Protection, by Hugh MacRae, March 13, 1912. 5 pp.
62. Forestry Notes, April 10, 1912. 4 pp.
63. A Forester's Notes from Europe, by J. S. Holmes. June 20, 1912. 4 pp.
64. Timber Resources of Polk County, July 3, 1912. 3 pp.
65. Timber Resources of Rutherford County, July 3, 1912. 3 pp.
66. Timber Resources of McDowell County, July 3, 1912. 3 pp.
67. Timber Resources of Burke County, July 3, 1912. 3 pp.
68. Timber Resources of Caldwell County, July 3, 1912. 3 pp.
69. Timber Resources of Wilkes County, July 3, 1912. 3 pp.
70. Timber Resources of Alexander County, July 3, 1912. 3 pp.
71. Timber Resources of Cleveland County, July 3, 1912. 3 pp.
72. Timber Resources of Catawba County, July 3, 1912. 3 pp.
73. Timber Resources of Mecklenburg County, July 3, 1912. 3 pp.
74. Timber Resources of Cabarrus County, July 3, 1912. 3 pp.
75. Timber Resources of Iredell County, July 3. 1912. 3 pp.
76. Timber Resources of Rowan County, July 3, 1912. 3 pp.
77. Timber Resources of Davie County, July 3, 1912. 3 pp.
78. Timber Resources of Yadkin County, July 3, 1912. 3 pp.
79. Timber Resources of Davidson County, July 3, 1912. 3 pp.
80. Timber Resources of Forsyth County, July 3, 1912. 3 pp.
81. Timber Resources of Stokes County, July 3, 1912. 4 pp.
82. Timber Resources of Lincoln County, July 3, 1912. 3 pp.
83. Timber Resources of Surry County, July 3, 1912. 3 pp.
84. Timber Resources of Gaston County, July 3, 1912. 3 pp.
85. A Forester's Notes from Europe, by J. S. Holmes, July 18, 1912. 3 pp.
86. Mineral Production in North Carolina During 1911, August 21, 1912. 2 pp.
87. A Forester's Notes from Europe, by J. S. Holmes, August 30, 1912. 4 pp.
88. Scouting for the Chestnut Blight in North Carolina, October 24, 1912. 3 pp.
89. Drainage Convention, October 28, 1912. 3 pp.
90. A Forester's Notes from Europe, by J. S. Holmes, November 8, 1912. 4 pp.
91. Timber Resources of Western North Carolina, November 15, 1912. 4 pp.
92. Forestry Notes, November 18, 1912. 6 pp.
93. Program of Annual Drainage Convention, November 23. 1912. 4 pp.

The following reports are either in the hands of the public printer or ready to be handed in:

VOLUMES.

IV. Birds of North Carolina, by T. Gilbert Pearson, H. H. Brimley, and C. H. Brimley.

V. Reptilian Fossils of North Carolina, by Charles W. Gilmore.

BULLETINS.

24. Virgilina Copper District. A joint report of the North Carolina Geological and Economic Survey and the Virginia Geological Survey.

ECONOMIC PAPERS.

32. Proceedings of the Annual Drainage Convention, compiled by Joseph Hyde Pratt.
33. Public Roads are Public Necessities, by Joseph Hyde Pratt.

The following reports are in preparation:

VOLUMES.

Mineral Resources of North Carolina.
Mica and Pegmatites in North Carolina.

BULLETINS.

Road Construction and Maintenance.
A List of Elevations in North Carolina.
The Loblolly Pine in Eastern North Carolina.
Timber Resources of the Twenty-four Counties East of the Blue Ridge.
The Swamp Lands of North Carolina.

FINANCIAL STATEMENT

There is given below a statement which shows receipts and expenditures of the North Carolina Geological and Economic Survey for the two years ending November 30, 1912, grouped according to subjects investigated during this time. These are arranged separately for the two years. The *receipts* cover moneys received from the State Treasury, representing the annual appropriation and other sums received from individuals for coöperative work of various kinds as indicated, and from other sources:

December 1, 1910, to November 30, 1911.

RECEIPTS.		
Balance on hand		$1.88
Annual appropriation		10,000.00
Annual appropriation for roads		5,000.00
Cash on account of Bingham Township road		10.00
Cash on account of Central Highway from private individuals		210.00
Cash from the U. S. Office of Public Roads on account of coöperative road work		55.00
Cash from the Carolina and Northwestern Railroad, on account of coöperative forestry work		100.00
Cash from the State Fair, on account of expense for installing exhibit		30.67
Redeemed railroad ticket		.70
DISBURSEMENTS.		
General geological and mineralogical investigations	$1,206.80	
Forestry investigations	2,968.45	
Drainage investigations	666.98	
Fish and oyster investigations	312.50	
Good roads investigations	5,254.05	
Geological Board expenses	167.65	
Clerical and editorial work	3,012.69	
Other office expenses	1,814.86	
Balance on hand	4.27	
	$15,408.25	$15,408.25

DECEMBER 1, 1911, TO NOVEMBER 30, 1912.

RECEIPTS.

Balance on hand		$4.27
Annual appropriation		10,000.00
Annual appropriation for highway work		5,000.00
Back payment for highway work		1,250.00
Refund from hotel bill		1.50
Loan (on account of quarterly appropriation)		3,750.00
Refund from hotel bill		2.50
Check for assaying		3.00
Cash from the Carolina and Northwestern Railroad on account of coöperative forestry work		100.00
Cash on account of road work in Polk County		31.50
Refund from railroad ticket		3.50

DISBURSEMENTS.

General geological and mineralogical investigations	$1,185.80	
Topographic and traverse mapping	230.00	
Bibliography	877.93	
Forestry investigations	2,243.10	
Drainage investigations	843.22	
Fish and oyster investigations	447.05	
Good roads investigations	5,097.32	
Geological Board expenses	115.45	
Clerical and editorial work	2,961.30	
Other office expenses*	5,603.60	
Balance on hand	541.50	
	$20,146.27	$20,146.27

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*This includes a return of the loan of $3,750.00 with interest.

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain. 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe. 1897. 8°, 227 pp.. 22 pl. *Out of print.*

7. Forest Fires: Their Destructive Work. Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*

8. Water-powers in North Carolina. by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Postage 4 cents.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Postage 4 cents.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*

14. The Cultivation of the Diamond-back Terrapin, by R .E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglass B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 115 pp., 8 pl. *Postage 15 cents.*

ECONOMIC PAPERS.

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal, in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a list of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestones; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Postage 2 cents.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Postage 4 cents.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Postage 3 cents.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 15 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina containing a Statistical Report of Road Work During 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention Held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two Trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh,

N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking-waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

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Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

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Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

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Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Co-operation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connally Tract, Buncombe County; Transylvania County

State Farm, certain Watersheds, Reforestation of Cut-over and Abandoned Farm Lands, on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county-seats in North Carolina; list of Magnetic Declination at the county-seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

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